RAN LIU

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

SUMMARY

I am a Ph.D. candidate in the Machine Learning program of Georgia Tech. My research interests include large-scale pretraining and alignment of transformers, representation learning with contrastive methods and data augmentations, and explainable learning methods for timeseries and images.

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 Jun 2019

INTERNSHIPS

Apple AI/ML, Cupertino, CA Jan 2023 - Aug 2023
Research Scientist Intern, advised by Dr. Ali Moin (collaborator: Dr. Hadi Pouransari)

- Led a research project developing efficient transformer architectures with Fourier Neural Operators for large-scale pretraining on multi-modal time series and biosignals. Patent application submitted.

Cajal Neuroscience, Seattle, WA May 2022 - Aug 2022
Machine Learning Research Intern, advised by Dr. Jennifer Whitesell

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

Facebook (now Meta Platforms), Menlo Park, CA May 2021 - Aug 2021
Research Intern, 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.

C10 **Ran Liu**, 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.

[1] Contributed equally, ordered alphabetically.

Peer Reviewed Conference Proceedings

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

C8 **Ran Liu**, 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, **Ran Liu**, 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 **Ran Liu**, 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, **Ran Liu**, 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, **Ran Liu**, Eva L Dyer., "Building representations of different brain areas through hierarchical point cloud networks.", Medical Imaging with Deep Learning (**MIDL**), 2022.

C3 **Ran Liu**, 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, **Ran Liu**, 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 **Ran Liu**, 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, **Ran Liu**, 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, **Ran Liu**, 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, **Ran Liu**, 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, **Ran Liu**, 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, **Ran Liu**, 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.

AWARDS

Apple Research Program Sponsorship (received as co-PI)	2024
NSF CloudBank Sponsorship (received as co-PI)	2024
CSIP Outstanding Research Award	2023
Rising Stars in EECS (1 of 101 awardees)	2023
ICML Diversity and Inclusion Fellowship	2020
Cox Fellowship	2019
China National Scholarship (highest undergraduate scholarship nationally)	2018
Chun-Tsung Scholar	2018
Outstanding Leadership Awards (1 of 10 awardees)	2018
First Prize of Outstanding Students Scholarship (awarded to top 5%)	2016

RESEARCH EXPERIENCE

Large-scale Pretraining and Alignment for Time Series and Beyond Jan 2022 - Present

- Proposed a theoretically grounded framework to evaluate representation spaces of 11 pretrained vision encoders, and proposed an ensembling method that combines differently augmented images to improve classification on ImageNet without any training (Spectra Imbalance, submitted to ICML 2024).
- Developed a group-aware embedding technique that compensates traditional positional embedding that learns explainable spatiotemporal structure on time series (GAFormer, accepted by ICLR 2024).
- Proposed a frequency-aware architecture and pretraining strategy with Fourier Neural Operator for efficient pretraining on largescale multimodal biosignals (bioFAME, arXived and patented).
- Developed a multi-stage transformer that learns across datasets by disentangling the individual dynamics and collective dynamics of multi-channel time-series (EIT, accepted by NeurIPS 2022).

Representation Learning, Contrastive Methods, and Data Augmentation Jan 2020 - Present

- Implemented a framework that unifies contrastive learning methods through distribution alignment of views with optimal transport (GCA, submitted to ICML 2024).
- Proposed a latent space augmentation method inspired by diffusion models that degrades and restores representations to improve learning on images (LatentDR, accepted by WACV 2024).
- Developed a self-supervised learning framework based on latent space augmentation to perform latent space disentanglement (SwapVAE, accepted by NeurIPS 2021 as **oral presentation**, top 1%).
- 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).

Generative Modeling and Segmentation of Medical Images Jan 2020 - Jan 2022

- Developed a neural imaging benchmark for multiscale brain structure classification and segmentation (MTNeuro, accepted by NeurIPS 2022 Datasets and Benchmarks).

- 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).

Quantum Physics and Superconductivity Feb 2017 - Jun 2019

- Discovered a new type of quantum Hall effect in wedge-like Cd_3As_2 thin films (Nature, 2019).
- Explored proximity-induced Fermi-arc superconductivity in Nb/Cd_3As_2 heterostructures and supercurrent in $Nb/Cd_3As_2/Nb$ Josephson junctions (Nat. Commun., 2019).
- Fabricated $NbSe_2/WTe_2$ hybrid structures and investigated the proximity-induced superconductivity in topological Weyl materials (ACS nano, 2018).

PROFESSIONAL EXPERIENCES

Talks and Presentations

- "Generalizable and Interpretable Representation Learning for Neuroscience", EECS Rising Star, 2023.
- "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 ICML 2024, 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)