RAN LIU

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RESEARCH INTERESTS

My research interests lie at the intersection of deep learning, computational neuroscience, and computer vision. I am actively working on developing methods that achieve the following goals:

- Learning without explicit human annotation through self-supervision and generative modeling,
- Building deep learning architectures that are interpretable, identifiable, and generalizable,
- Developing efficient deep learning methods for large-scale image segmentation with limited or noisy annotations, explicit constraints, or topological/geometrical priors.

EDUCATION

Georgia Institute of Technology
Ph.D. student in Machine Learning - ECE   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

PUBLICATIONS

- **Liu, R.**, Azabou, M., Dabagia, M., Xiao, J., Dyer, E. L., "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.

- Quesada, J., Sathidevi, L., **Liu, R.**, Ahad, N., Jackson, J. M., Azabou, M., et al., "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), 2022.

- Jackson, J. M., **Liu, R.**, Dyer, E. L., "Building representations of different brain areas through hierarchical point cloud networks.", Medical Imaging with Deep Learning (**MIDL**), 2022.

- **Liu R.**, Azabou M., Dabagia M., Lin C-H., Gheshlaghi Azar M., Hengen K. B., Valko M., Dyer E. L., "Drop, Swap, and Generate: A Self-Supervised Approach for Generating Neural Activity", the Conference on Neural Information Processing Systems (**NeurIPS**), **oral (top 1%)**, 2021.

- Azabou, M., Azar, M. G., **Liu, R.**, Lin, C. H., Johnson, E. C., Bhaskaran-Nair, K., Dabagia M., et al., "Mine Your Own vieW: Self-supervised learning through across-sample prediction", arXiv, 2021.

- Balwani, A., Miano, J., **Liu, R.**, Kitchell, L., Prasad, J.A., Johnson, E.C., Gray-Roncal, W. and Dyer, E.L., "Multi-scale modeling of neural structure in X-ray imagery", to appear at the IEEE International Conference on Image Processing (**ICIP**), 2021.

- **Liu, R.**, Subakan, C., Balwani, A. H., Whitesell, J., Harris, J., et al., "A generative modeling approach for interpreting population-level variability in brain structure", to appear in International Conference on Medical Image Computing and Computer Assisted Intervention (**MICCAI**), 2020.

- Huang C., Zhou B., Zhang H., Yang B., **Liu R.**, et al. "Proximity-induced surface superconductivity in Dirac semimetal Cd_3As_2", **Nature Communications**, May 2019.

- Zhang C., Zhang Y., Yuan X., Lu S., Zhang J., Narayan A., Liu Y., Zhang H., Ni Z., **Liu R.**, et al. "Quantum Hall effect based on Weyl orbits in Cd_3As_2", **Nature**, Jan. 2019.

- Huang C., Narayan A., Zhang E., Liu Y., Yan X., Wang J., Zhang C., Wang W., Zhou T., Yi C., Liu S., Ling J., Zhang H., **Liu R.**, et al. "Inducing Strong Superconductivity in WTe_2 by Proximity Effect", **ACS nano**, June 2018.

INDUSTRY EXPERIENCE

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

- Developed 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 Meta Platforms, Inc. (Facebook, Inc.)   May 2021 - August 2021
Physical modeling team, advised by Dr. Andrew Grier

- Implemented physics-assisted U-Net to model the environmental change process guided by Navier Stokes equations in order to model and predict infrastructure physical parameters.

SELECTED RESEARCH PROJECTS

Using self-supervision and generative modeling to study brain   Jan 2020 - Present
Advisor: Prof. Eva Dyer, Georgia Institute of Technology

- Developed a multi-stage transformer to disentangle and interpret the individual dynamics and collective dynamics of neural activities (EIT, submitted to NeurIPS 2022).
- Developed a self-supervised learning algorithm based on latent space augmentation to perform generative modeling and latent space disentanglement of neural activities (SwapVAE, accepted by NeurIPS 2021 as oral presentation).
- Developed a self-supervised representation learning method based on nearest-neighbor search inside the latent space, and applied the method on both vision and neural datasets (MYOW, arXiv).
- 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).

Temporal modeling and prediction of controversial posts   Aug 2019 - Dec 2019
Advisor: Prof. Diyi Yang, Georgia Institute of Technology

- Applied and adjusted state-of-the-art machine learning models (including BERT, BiLSTM, CRF, etc.) on a classification task of discourse acts and achieved record-high F1 score.
- Designed and extracted domain knowledge features about controversy-causing posts and employed those features on the early prediction of controversial posts on Reddit.
- Conducted temporal modeling of controversial posts' discussion structures with linguistic analysis of discourse acts and conversational interaction feature engineering results.

Link recommendation based on hierarchical graph analysis   Jan 2019 - Jun 2019
Advisor: Prof. Deqing Yang, Fudan University

- Constructed a hierarchical information graph based on user connections and geo-locations obtained from a self-crawled Twitter dataset.
- Conducted community detection based on modified fast unfolding algorithm.
- Designed a heterogeneous recommendation system via link prediction algorithms including Neural Collaborative Filtering and Factorization Machine.

Characteristic analysis of complex networks — Jul 2018 - Jan 2019
Advisor: Prof. Zhongzhi Zhang, Fudan University

- Analytically derived the Laplacian spectrums of several special scale-free complex networks with identical degree sequence.
- Calculated characteristic invariants including the enumeration of spanning trees of the studied complex networks, and related their properties to the consensus problem.
- Obtained the relationship between power-law degree distribution and consensus behavior on scale-free networks via the differences between fractal and non-fractal complex networks.

Investigation on physical properties of innovative nanodevices — Feb 2017 - Oct 2018
Advisor: Prof. Faxian Xiu, Fudan University

- 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).

PROFESSIONAL EXPERIENCES

Mentoring

- Mentored undergraduate students and master's students in Neural Data Science Lab

Conference reviewing

- Reviewer of ICLR 2023, NeurIPS 2022
- Sub-reviewer of NeurIPS 2021, ICML 2021, ICLR 2021, NeurIPS 2020, ACL 2019

Graduate Teaching Assistant at Georgia Institute of Technology

- Introduction to Signal Processing at Electrical and Computer Engineering (2019 Fall)

AWARDS AND RECOGNITIONS

- ICML Diversity and Inclusion Fellowship	2020
- Cox Fellowship from Georgia Tech	2019 - 2020
- 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
- First Prize of Outstanding Students Scholarship from Fudan — awarded to top 5%	2016
- Outstanding Leadership Awards — honored to 10 student activity organizers per year	2018

SKILLS

- Programming Languages	Python, MATLAB, SQL, Java, C/C++
- Open Source Libraries	PyTorch, TensorFlow, Keras, scikit-learn, OpenCV, Gensim, etc.