Yushu Pan

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RESEARCH INTEREST

My research interests lie broadly in **Vision-Language Models** and **Causal Inference**. I develop methods that integrate causal reasoning to enhance the **controllability, reasoning capabilities, efficiency, and interpretability** of generative models.

My work spans a range of domains, including **multi-modal (text-to-image) generation**, **diffusion**, **generative recommendation systems** with the goal of making generative AI more robust and controllable in real-world settings.

EDUCATION

- **Columbia University - Ph.D. in Computer Science** *Sep 2021 - Expected Dec 2026*
  GPA: 4.0/4.0   Advisor: *Prof. Elias Bareinboim* New York, United States

- **California Institute of Technology - MS in Electrical Engineering** *Sep 2019 - Jun 2021*
  GPA: 4.2/4.3   Advisor: *Prof. Yisong Yue* Pasadena, United States

- **Beijing Institute of Technology - BS in Electrical Engineering** *Sep 2015 - Jun 2019*
  GPA: 93/100   Ranking: 1/425   Advisor: *Prof. Yuantao Gu* Beijing, China

- **Peking University - Bachelor of Economics** *Sep 2017 - Jun 2019*
  GPA: 3.7/4.0 Beijing, China

PUBLICATIONS

[C1] **Pan, Y.** and Bareinboim, E. "Counterfactual Image Editing with Disentangled Causal Latent Space", Accepted in 39th Conference on Neural Information Processing Systems, (**NeurIPS**), 2025.

[C2] Hwang, I., **Pan, Y**., Bareinboim, E. "From Black-box to Causal-box: Towards Building More Interpretable Models", Accepted in 39th Conference on Neural Information Processing Systems, (**NeurIPS**), 2025.

[C3] **Pan, Y**[*]., Li, A[*]., Bareinboim, E. "Disentangled Representation Learning in Non-Markovian Causal Systems", In 38th Conference on Neural Information Processing Systems (**NeurIPS**), 2024. *Contributed equally, Author names in alphabetical order*

[C4] **Pan, Y.** and Bareinboim, E. "Counterfactual Image Editing", In Proceedings of International Conference on Machine Learning (**ICML**), 2024.

[C5] Xia, K., **Pan, Y.**, Bareinboim, E. "Neural Causal Models for Counterfactual Identification and Estimation", In International Conference on Learning Representations, (**ICLR**), 2023.

[C6] **Pan, Y.**, Jiao, Y., Li, T., Gu, Y. "An efficient algorithm for hyperspectral image clustering", IEEE International Conference on Acoustics, Speech and Signal Processing (**ICASSP**), 2019.

INDUSTRIAL EXPERIENCE

- **Long-sequence Recommendation — Ph.D. Research Scientist Intern at Meta** *May 2025 – Aug 2025*
  Meta Platforms, Inc.
  ◦ Led the research and development of **Long-Short Hierarchical Sequential Transduction Units (LS-HSTU)**, a **transformer**-like generative recommender, for long user history interactions.
  ◦ Implemented LS-HSTU in **Triton** and applied it to internal Instagram Reels data, achieving a **47.1% improvement in QPS** (query per second) while maintaining **comparable normalization entropy** (accuracy) to the production HSTU baseline.

- **Pulmonary Nodules Detection in CT Images - Undergrad Intern** *Dec 2017 - Mar 2018*
  Advisor: Prof. Yi Zhang, West China Hospital
  ◦ Implemented and optimized 3D-convolutional neural networks, and 3D-region proposal U-nets in PyTorch leading to 2x improved lung nodule detection with West China Hospital's CT scans.

Selected Research Projects

- **Text-to-Image Editing with Multi-Modal Large Models [C1, 4]** *Mar 2023 - present*
  Advisor: Prof. Elias Bareinboim, Columbia University
  - Developed CLS-Edit, a **post-training** algorithm for counterfactual image editing with **text-to-image diffusion** models. Enabled the effect from target edits to other visual features, mitigating biases from pre-trained models. Demonstrated superior performance in **reasoning** and **debiasing** compared to existing baselines.
  - Proposed Augmented Neural Causal Model (ANCM), a **Diffusion and VAE-based** framework for efficient counterfactual reasoning in image editing. Achieved **high-fidelity** and **semantically counterfactual inference** in image generation.

- **Causal Disentangled Representation Learning [C3]** *Oct 2023 – Present*
  Advisor: Prof. Elias Bareinboim, Columbia University
  - Proposed **CRID**, a graphical criterion and algorithm to determine whether learned representations are **causally disentangled** for downstream tasks.
  - Designed a flow-based method for extracting disentangled causal representations and applying them to downstream tasks, including image generation and **domain generalization** in weakly supervised settings.

- **Causal Neural Nets for Counterfactual Identification and Estimation [C5]** *Sep 2022 – May 2023*
  Advisor: Prof. Elias Bareinboim, Columbia University
  - Proposed **Neural Causal Models (NCMs)** for counterfactual identification and estimation with deep networks, addressing the limitations of observationally trained models in causal inference.
  - Developed the GAN-NCM structure and showed improved efficiency and accuracy in estimating causal queries over existing baselines.

- **Subspace Methods and Hyperspectral Image Clustering [C6]** *Mar 2018 -Jun 2019*
  Advisor: Prof. Yuantao Gu, Tsinghua University
  - Developed a superpixel-based **spectral clustering** algorithm for hyperspectral image analysis, achieving improved accuracy and efficiency over existing baselines on both medical and satellite imagery.

Honors and Awards

- **Greenwoods Fellowship** *Oct 2021*
  Fu Foundation of Engineering and Applied Science at Columbia University

- **Xu Te Li Scholarship (awarded to top 0.1% of undergraduates)** *May 2019*
  Beijing Institute of Technology

- **National Scholarship** *Dec 2017*
  Chinese Ministry of Education

- **Grand prize in the Excellence 9 Mathematical Competition of China** *Oct 2016*
  Excellence League

Teaching

- TA, CS 4775, Causal Inference I, Columbia University, Fall 2023-2025. 🌐
- TA, CS 4995, Causal Inference II, Columbia University, Spring 2023.
- TA, ACM 116, Introduction to Probability Models, Caltech, Fall 2020. 🌐

Skills

- **Programming Languages:** Python, C, Verilog, VHDL, Matlab
- **Packages:** Triton, Pytorch, Numpy, Pandas, SQL, Lightning, Git
- **ML:** Causal Inference, Diffusion Models, Transformers, LLMs, Multi-Modal Generation, Generative Recommenders