Yushu Pan

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RESEARCH INTEREST

My research interests focus on the intersection of causal inference and machine learning, under the supervision of Prof. Elias Bareinboim. I am particularly interested in causal generative models and causal representation learning.

EDUCATION

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

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

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

• **Peking University**   *Sep 2017 - Jun 2019*
Bachelor of Economics   Beijing, China
  ◦ GPA: 3.7/4

PUBLICATIONS

[1] Li, A[*]., **Pan, Y**[*]., 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

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

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

[4] **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.

SELECTED RESEARCH PROJECTS

• **Image Editing in Modern AI with Causality**   *Mar 2023 - present*
Advisor: Prof. Elias Bareinboim, Columbia University
  ◦ Developed a new causal framework for image editing tasks and theoretically proved that current state-of-the-art models cannot provide causal reliability for image editing tasks.
  ◦ Proposed **'counterfactual(ctf)-consistent estimators'** that ensure causal consistency between the features users prioritize for practical applications. Developed an algorithm called **Augmented Neural Causal Model (ANCM)** that efficiently provides ctf-consistent estimators and generates high-fidelity counterfactual images in extensive experiments.
  ◦ (Ongoing) Incorporate 'ctf-consistent estimators' with **text-to-image** pre-trained models (e.g., StableDiffusion, Latent Diffusion Model) to perform causal image editing using text prompts.

• **Causal Disentangled Representation Learning**   *Oct 2023 - present*
Advisor: Prof. Elias Bareinboim, Columbia University

- Formalized a general version of the causal representation learning problem and developed graphical criteria and an algorithm (**CRID**) to determine whether a pair of user-chosen variables are disentangled non-Markovian settings, considering arbitrary interventional and observational distributions from multiple heterogeneous domains.
- Developed a VAE-based algorithm to practically estimate causal disentangled representations and leverage them for image generation and downstream classification tasks.

- **Neural Causal Model for Counterfactual Identification and Estimation** *Sep 2022 - May 2023*
  Advisor: Prof. Elias Bareinboim, Columbia University
  - Theoretically proved that deep models are incapable of making causal inferences when trained solely on observational data. Developed a class of causal models using neural networks, called **Neural Causal Models (NCMs),** for counterfactual identification and estimation.
  - Developed a GAN-based implementation of Neural Causal Models (NCM) and conducted experiments to demonstrate the accuracy and efficiency of the GAN-NCM approach.

- **Data-Driven Optimization for ML Algorithms** *Jan 2020 - Sep 2021*
  Advisor: Prof. Yisong Yue, Caltech
  - Developed a data-driven continuous optimization approach for structure learning. Designed a meta-learning architecture and a reinforcement learning-based method to achieve auto-hyperparameter tuning.

- **Subspace Methods and Hyperspectral Images Clustering** *Mar 2018 - Jun 2019*
  Advisor: Prof. Yuantao Gu, Tsinghua University
  - Designed a high-accuracy SuperPixel and Angle-based HyperSpectral Image Clustering (SPAHSIC) algorithm with low time complexity, utilizing superpixel segmentation and principal angles between subspaces for hyperspectral image clustering. Performed SPAHSIC on medical and satellite hyperspectral images.

INDUSTRIAL EXPERIENCE

- **Pulmonary Nodules Detection in CT Images** *Dec 2017 - Mar 2018*
  Advisor: Prof. Yi Zhang, West China Hospital
  - Implemented and optimized 3D-conventional neural networks, 3D-region proposal U-nets for lung nodule detection with West China Hospital's CT images.

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 / Fall 2024. 🌐
- 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, CAD
- **Packages:** Pytorch, Tensorflow, Scikit-learn, Keras
- **Languages:** English (fluent), Chinese (native)