Xuzhe Zhang

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Education

Columbia University — New York, US
Ph.D. in Biomedical Engineering — *2020 – 2025(expected)*
Research: Deep Learning, Computer Vision, Medical Image Analysis
Advisor: Prof. Andrew F. Laine

Columbia University — New York, US
M.Sc. in Biomedical Engineering — *2018 – 2020*
Courses: computer vision, deep learning, machine learning, computational mathematics

Northeastern University — Shenyang, China
B.Eng. in Biomedical Engineering — *2014 – 2018*
Thesis: Segmentation and Classification of Lung Nodules on CT via Machine Learning
Courses: digital signal/image processing, medical imaging, C/C++, data structure, computer network

Research Interests

My research interests primarily lie in the intersection of ***deep learning***, ***computer vision***, and ***medical image analysis/computing***, with a focus on model robustness and generalist AI. I was/am focusing on the following problems and techniques:

Problems: semantic segmentation, model robustness, image generation/synthesis, image classification

Techniques: self-supervised learning, domain adaptation, self-attention, generative models, multimodal fusion

Recently, I've found the topics about in-context learning in vision models (or large vision model) quite exciting and seem to be a promising pathway to robust medical vision models, and I am actively exploring them.

Research Experience

Heffner Biomedical Imaging Lab, Columbia University — New York, US
Research Assistant, supervised by Prof. Andrew F. Laine — *Jan 2019 – Present*

- Generative Models for Medical Images:
  - Utilized synthetic lung MRI mask-image pairs (via unconditional & conditional GANs) for augmentation[9].
  - Proposed Pyramid Transformer Network for infant brain MRI cross-modality (contrast) translation[1][11].
- Transformers for Medical Image Analysis:
  - Developed fully attention-based network for image translation[1][11] and for skin lesion segmentation and classification[2].
- Robustness and Generalization of AI Models:
  - Proposed **MAPSeg**, the first unified unsupervised domain adaptation (UDA) framework for heterogeneous medical image segmentation via 3D **M**asked **A**utoencoding and **P**seudo-labeling[9]. MAPSeg works for centralized, federated, and test-time scenarios.
  - Curated an entropy-based UDA framework for cross-sequence lung MRI segmentation[8].
  - (*ongoing*) Robust and vendor-agnostic segmentation framework[10] to quantify pulmonary emphysema from CT, a pathology that is highly sensitive to subtle intensity change. Multimodal fusion (vision feature + quantitative scanner priors) is mainly explored.
  - (*ongoing*) Large vision model for medical image analysis.

GE Healthcare — California, US
AI/ML Ph.D. Intern, mentored by Bruno Astuto and Ravi Soni — *May – Aug 2023*

- A 12-week research internship at GE Healthcare AI and data science team.
  - Implemented and evaluated various designs of vision foundation model for robust MRI segmentation.
  - Project outcomes were submitted to *ISMRM* 2024, a prestigious conference focusing on MRI.

Publications

Journal Papers:

1. **Xuzhe Zhang**†, Xinzi He†, Jia Guo, Nabil Ettehadi, Natalie Aw, David Semanek, Jonathan Posner, Andrew Laine, Yun Wang, "PTNet3D: A 3D High-Resolution Longitudinal Infant Brain MRI Synthesizer Based on Transformers", *IEEE Transactions on Medical Imaging*, 2022 (**TMI**, IF=10.6)
2. Xinzi He, Ee-Leng Tan, Hanwen Bi, **Xuzhe Zhang**, Shijie Zhao, Baiying Lei, "Fully transformer network for skin lesion analysis", *Medical Image Analysis*, 2022 (**MedIA**, IF=10.9)
3. **Xuzhe Zhang**, Elsa D Angelini, Fateme S Haghpanah, Andrew F Laine, Yanping Sun, Grant T Hiura, Stephen M Dashnaw, Martin R Prince, *et al.*, "Quantification of lung ventilation defects on hyperpolarized MRI: The Multi-Ethnic Study of Atherosclerosis (MESA) COPD study", *Magnetic Resonance Imaging*, 2022
4. Nabil Ettehadi, Pratik Kashyap, **Xuzhe Zhang**, Yun Wang, David Semanek, Karan Desai, Jia Guo, Jonathan Posner, Andrew F Laine, "Automated Multiclass Artifact Detection in Diffusion MRI Volumes via 3D Residual Squeeze-and-Excitation Convolutional Neural Networks", *Frontiers in Human Neuroscience*, 2022
5. Vishwanatha M Rao, Zihan Wan, Soroush Arabshahi, David J Ma, Pin-Yu Lee, Ye Tian, **Xuzhe Zhang**, Andrew F Laine, Jia Guo, "Improving across-dataset brain tissue segmentation for MRI imaging using transformer", *Frontiers in Neuroimaging*, 2022
6. Naz P Taskiran, Grant T Hiura, **Xuzhe Zhang**, R Graham Barr, Stephen M Dashnaw, Eric A Hoffman, Daniel Malinsky, *et al.*, "Mapping Alveolar Oxygen Partial Pressure in COPD Using Hyperpolarized Helium-3: The Multi-Ethnic Study of Atherosclerosis (MESA) COPD Study", *Tomography*, 2022

Conference Proceedings:

7. Nabil Ettehadi, **Xuzhe Zhang**, Yun Wang, David Semanek, Jia Guo, Jonathan Posner, Andrew F Laine, "Automatic volumetric quality assessment of diffusion MR images via convolutional neural network classifiers", 2021 43rd *Annual International Conference of the IEEE Engineering in Medicine & Biology Society* (EMBC)

Under Review and Preprints:

8. **Xuzhe Zhang**, Christopher B. Cooper, Martin R. Prince, Bharath Ambale-Venkatesh, Prachi P. Agarwal, Michael C. Backman, David A. Bluemke, *et al.*, "MRI Assessed Dynamic Hyperinflation Induced by Tachypnea in Chronic Obstructive Pulmonary Disease: The SPIROMICS-HF Study", submitted to *Radiology* (IF=19.7)
9. **Xuzhe Zhang**†, Yuhao Wu†, Elsa Angelini, Ang Li, Jia Guo, Jerod M. Rasmussen, Thomas G. O'Connor, Pathik D. Wadhwa, Andrea Parolin Jackowski, Hai Li, Jonathan Posner, Andrew F. Laine‡, Yun Wang‡, "MAPSeg: Unified Unsupervised Domain Adaptation for Heterogeneous Medical Image Segmentation Based on 3D Masked Autoencoding and Pseudo-Labeling", arXiv 2023
10. **Xuzhe Zhang**, Elsa Angelini, Eric Hoffman, Karol Watson, Benjamin Smith, R Graham Barr, Andrew Laine, "Robust Quantification of Percent Emphysema on CT via Domain Attention: the Multi-Ethnic Study of Atherosclerosis (MESA) Lung Study", submitted to *IEEE International Symposium on Biomedical Imaging* 2024
11. **Xuzhe Zhang**†, Xinzi He†, Jia Guo, Nabil Ettehadi, Natalie Aw, David Semanek, Jonathan Posner, Andrew Laine, Yun Wang, "PTNet: A high-resolution infant MRI synthesizer based on transformer", arXiv 2022
12. Xinzi He, Jia Guo, **Xuzhe Zhang**, Hanwen Bi, Sarah Gerard, David Kaczka, Amin Motahari, Eric Hoffman, Joseph Reinhardt, R Graham Barr, Elsa Angelini, Andrew Laine, "Recursive refinement network for deformable lung registration between exhale and inhale ct scans", arXiv 2022

† and ‡ denote co-first and co-senior authors, respectively.

Open-source

Online Infant Neuroimaging Analysis platform | https://www.finneas.ai/

- An ongoing effort to facilitate neuroscience and early brain development studies by providing robust segmentation and quantification of subcortical regions via a web-based platform powered by AWS.
- Featured robust model pretrained and semi-supervised fine-tuned on around 8,000 volumetric newborn-to-toddler structural brain MRI based on MAPSeg[9].
- More features are coming soon, including test-time and federated adaptation, open-source support, and preprocessing tools.

PTNet3D | GitHub

- Public code repository for PTNet3D[1], one of the first works introducing transformers to medical image synthesis.

MAPSeg | *coming soon*

- Official implementation of MAPSeg[9], the first unified UDA framework for heterogeneous medical image segmentation.

Services & Talks & Awards

Reviewer

IEEE Transactions on Medical Imaging 2023
Medical Image Analysis 2023
MICCAI: International Conference on Medical Image Computing and Computer-Assisted Intervention 2023

Teaching Assistant

Deep Learning in Biomedical Imaging (Columbia BMEN4460, graduate-level) Spring 2022 & 2023

Guest Lecturer

Avoiding Data Loss for Infant Brain Structural MRI via Generative Models Columbia BMEN4460 2022 & 2023

Challenge Organization

IEEE COVID-19 Imaging Informatics Challenge IEEE Healthcare Summit (IHS) 2021

Oral Presentation

Ventilation defect quantification on 3He MRI through deep learning: the MESA COPD Study ERS 2020

Scholarships

Northeastern University Scholarship 2016 & 2017
Sino-Dutch Biomedical and Information Engineering School Scholarship 2016

Skills

Programming: Python, LaTeX, Shell, MATLAB, C/C++

Libraries/Tools/Softwares: PyTorch, Tensorflow, Git, GCP/AWS, ANTs, ITK-SNAP, 3D Slicer, MeshLab, ImageJ

Languages: Chinese (native), English (fluent)