Chengyin Li

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RESEARCH INTERESTS

My research interests center around solving core **computer vision** and **trustworthy AI** problems and applying the developed learning approaches to broad AI applications, such as **medical image analysis**, **visual/multimodal foundation models**, **explainability**, and **healthcare**.

RESEARCH EXPERIENCE

Trustworthy AI Lab at Wayne State University, Graduate Research Assistant Aug 2019 – Present

- **Medical Imaging Applications**
  - Proposed FocalUNETR, a new focal transformer-based segmentation architecture for CT-based prostate segmentation task, for efficiently extracting local features and global context. Introduced an auxiliary boundary-aware regression task alongside the main segmentation task to address the unclear boundary issue in the prostate segmentation task. Published one top conference paper in **MICCAI-2023** [1] as the first author.
  - Proposed SwinAttUNet, a novel architecture that integrates both convolutional and transformer operations at the feature extraction stage for multi-organ 3D medical image segmentation tasks. Published one journal paper in **Medical Physics** [2] as the first author.
  - Proposed a novel method, AutoSAM Adapter, specifically for 3D multi-organ CT-based segmentation. Employed parameter-efficient adaptation techniques to facilitate the transformation of the visual foundation model SAM from 2D natural image to 3D medical image domain, meanwhile eliminating the need for manually generated prompts. Submitted one top conference paper in **AAAI-2024** [3] as the first author.
  - Proposed a lightweight network-based mobile app named COVID-MobileXpert, which can be used for COVID-19 case screening and radiological trajectory prediction. Designed a training strategy and in-house loss function to improve the performance of this lightweight model to the same level as the large-size models. Published one conference paper in **BIBM-2020** [12].
- **AI for Social Good**
  - Proposed a personalized and resource-aware electric vehicle charging recommendation method using a regularized reinforcement learning approach with an actor-critic model that balances driver preferences with external rewards like minimizing driving and wait time. Published one top conference paper (oral) in **ECML PKDD-2022** [5] as the first author.
  - Reviewed how machine learning techniques can aid in the detection of biologically meaningful changes in miRNA-omics data. Also provided an overview of the latest research on miRNAs and their potential as biomarkers for various pediatric conditions. Published one journal paper in **Pediatric Research** [6] as the first author.
- **Explainability**
  - Proposed a novel explanation technique via attentive class activation tokens named AttCAT, leveraging encoded features, their gradients, and their attention weights to generate a faithful and confident explanation for the Transformer's output. Published one top conference paper in **NeurIPS-2022** [10].
  - Proposed a novel saliency-guided adversarial training scheme for learning generalizable features. This approach demonstrates impressive performance on OOD test sets compared to the baseline methods. Published one conference paper in **ICML-2022** Workshop [11].
  - Developed a novel DNN model explanation method named NeFLAG. This approach converts a volume integration of the second-order gradients to a surface integration of the first-order gradients by applying the divergence theorem, resulting in more faithful explanations. Published one top conference paper in **IJCAI-2023** [7].
  - Proposed an interpretability-aware variant of Vision Transformer (ViT) named IA-ViT, which consists of three major components: a feature extractor, a predictor, and an interpreter. By training the predictor and interpreter jointly with a novel interpretability-aware objective, IA-ViT achieves improved interpretability without a significant loss in predictive performance. Submitted one top conference paper in **AAAI-2024** [14].
- **Foundational AI Research**
  - Designed counterfactual interpolation augmentation (CIA), a novel data augmentation strategy to improve DNN fairness via de-correlating the target variable from the sensitive attribute based on counterfactual causal inference. Designed counterfactual gradient integration leveraging the counterfactual interpolations from CIA to generate high-quality and fair explanations. Published one conference paper in **IJCAI-2022** [9].
  - Proposed Prox-DRO, a proximal algorithm to solve compositional optimization problems that often arise in distributionally robust optimization formulations. Prox-DRO circumvents the need for large accuracy-dependent batch gradients and function evaluations, demonstrated to be feasible for most practical settings. Published one conference paper in **ICML-2023** Workshop [8].
  - Developed a novel framework, named debiased self-attention (DSA), which is a fairness-through-blindness approach that enforces ViT to eliminate spurious features correlated with the sensitive attributes for bias mitigation. DSA leads to improved fairness guarantees over prior works on multiple prediction tasks without compromising target prediction performance. Submitted one top conference paper in **AAAI-2024** [13].

WORK EXPERIENCE

Henry Ford Health , Research Scientist — May 2022 – Present

- Developed deep/machine learning algorithms for 2D/3D medical image (CT, MRI) segmentation tasks. Explored the Visual Foundation Models (VFMs) to improve the performance of medical image segmentation tasks [3].
- Proposed SwinAttUNet, a novel deep learning architecture combining convolutional and transformer networks in a parallel encoding scheme, which achieved state-of-the-art performance for automatic 3D multi-organ segmentation on CT images. Outperformed existing networks on public and internal datasets for segmentation of pelvic, thoracic, and abdominal organs, with Dice scores of 86-98%. Published one abstract with an oral talk in **AAPM-2023** and one journal paper in **Medical Physics** [2] as the first author.
- Developed a novel medical image segmentation approach using an ensemble of deep learning models trained with diverse loss functions (Cross-Entropy, Dice, Boundary, Top-K) to enhance segmentation performance. Proposed a learnable ensemble technique that dynamically combines multiple loss-driven feature extraction modules and convolutional operations for robust segmentation. Demonstrated superior performance of the learnable ensemble approach compared to single loss and linear combination methods, with statistical significance. Submitted one journal paper to **Physics in Medicine & Biology** [4] as the first author.

The Shenzhen Institutes of Advanced Technology, Research Assistant — Sep 2017 – Dec 2018

- Collaborated with other members to build a prototype of a real-world image-denoising system. Applied deep learning algorithms based on the BasicSR to perform UNet-like end-to-end denoising tasks.
- Developed a proof-of-concept generative adversarial network (GAN) to enhance images through denoising and super-resolution techniques.

EDUCATION

Wayne State University, Detroit, Michigan, USA

- Doctor of Philosophy in Computer Science — Aug 2019 – Expected Spring 2024
  - Cumulative GPA: 3.95 / 4.0
- Master in Computer Science — Aug 2019 – Dec 2020
  - Cumulative GPA: 3.95 / 4.0

University of Chinese Academy of Sciences, Beijing, China

- Master of Science in Chemical Engineering — Sep 2013 – Jul 2016

Nanjing University of Science and Technology, Nanjing, China

- Bachelor in Chemical Engineering — Sep 2009 – Jul 2013

SKILLS

Programming: Python (Numpy, Pandas), C++, Java, PyTorch, TensorFlow, HuggingFace, MONAI, ...
Machine Learning & AI: Medical Imaging, Computer Vision, Visual Foundation Models, Natural Language Processing, Unsupervised/Self-supervised Learning, Explainability, Fairness, Robustness
Tools: SQL, Matlab, R, MS Office, LaTeX, Git, Google AI Platform, Amazon Web Services (AWS)
Languages: Mandarin (native), English (business fluent)

HONORS AND AWARDS

- Graduate Student Professional Travel Award
- Outstanding Graduate Research Assistant Award
- Thomas C. Rumble University Graduate Fellowships

PROFESSIONAL ACTIVITIES

Conference Reviewer

- MICCAI: International Conference on Medical Image Computing and Computer Assisted Intervention
- AdvML: ICML Workshop on New Frontiers in Adversarial Machine Learning

Journal Reviewer

- IEEE Transactions on Medical Imaging
- Scientific Reports – Nature
- Smart Health
- BMC Genomics

PUBLICATIONS AND PRE-PRINTS

[1] Li, C., Qiang, Y., Sultan, R., Bagher-Ebadian, H., Khanduri, P., Chetty, I.J. and Zhu, D. (2023). "FocalUNETR: A Focal Transformer for Boundary-aware Prostate Segmentation using CT Images". *The* 26^{th} *International Conference on Medical Image Computing and Computer Assisted Intervention (MICCAI)*.

[2] Li, C., Bagher-Ebadian, H., Sultan, R., Mohamed, E., Movsas, B., Zhu, D. and Chetty, I.J. (2023). "A New Architecture Combining Convolutional and Transformer-Based Networks for Automatic 3D Multi-Organ Segmentation on CT Images." *Medical Physics*.

[3] Li, C., Khanduri, P., Qiang, Y., Sultan, R. I., Chetty, I., and Zhu, D. (2023). Auto-Prompting SAM for Mobile Friendly 3D Medical Image Segmentation. *arXiv:2308.14936 [cs.LG]*.

[4] Li, C., Qiang, Y., Sultan, R., Bagher-Ebadian, H., Zhu, D., Thind, K., and Chetty, I.J. (2023). "Improved Robust Medical Image Segmentation with Multiple Loss-Based Ensemble Model." *Under-review*.

[5] Li, C., Dong, Z., Fisher, N., and Zhu, D. (2022). "Coupling User Preference with External Rewards to Enable Driver-centered and Resource-aware EV Charging Recommendation." *The* 23^{rd} *European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECML-PKDD). Oral.*

[6] Li, C., Sullivan, R. E., Zhu, D., and Hicks, S. D. (2022). "Putting the "mi" in Omics: Discovering Mirna Biomarkers for Pediatric Precision Care". *Pediatric Research*.

[7] Li, X., Pan, D., Li, C., Qiang, Y., and Zhu, D. (2023). "Negative Flux Aggregation to Estimate Feature Attributions". *The* 32^{nd} *International Joint Conference on Artificial Intelligence (IJCAI).*

[8] Khanduri, P., Li, C., Sultan, R.I., Qiang, Y., Kliewer, J. and Zhu, D. (2023). "Proximal Compositional Optimization for Distributionally Robust Learning". *ICML 2023 New Frontiers in Adversarial Machine Learning Workshop*.

[9] Qiang, Y., Li, C., Brocanelli, M., and Zhu, D. (2022). "Counterfactual interpolation augmentation (CIA): A unified approach to enhance fairness and explainability of DNN". *The* 31^{st} *International Joint Conference on Artificial Intelligence (IJCAI)*.

[10] Qiang, Y., Pan, D., Li, C., Li, X., Jang, R., and Zhu, D. (2022). "AttCAT: Explaining Transformers via Attentive Class Activation Tokens". *Thirty-sixth Conference on Neural Information Processing Systems (NeurIPS)*.

[11] Li, X., Qiang, Y., Li, C., Liu, S., and Zhu, D. (2022). "Saliency-guided Adversarial Training for Learning Generalizable Features with Applications to Medical Imaging Classification System". *ICML 2022 New Frontiers in Adversarial Machine Learning Workshop*.

[12] Li, X., Li, C., and Zhu, D. (2020). "COVID-MobileXpert: On-device COVID-19 Patient Triage and Follow-up Using Chest X-rays". *International Conference on Bioinformatics and Biomedicine (BIBM)*.

[13] Qiang, Y., Li, C., Khanduri, P., and Zhu, D. (2023). "Fairness-aware Vision Transformer via Debiased Self-Attention". *arXiv:2301.13803 [cs.LG]*.

[14] Qiang, Y., Li, C., Khanduri, P., and Zhu, D. (2023). "Interpretability-Aware Vision Transformer". *arXiv:2309.08035[cs.LG]*.