Dewen Zeng

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RESEARCH INTEREST

Artificial Intelligence in Medical Data: Medical Image Segmentation; Self-Supervised Learning; Spatial-Temporal Data Analysis; Model Quantization, Efficient Segmentation;

EDUCATION

09/2019 – Present	University of Notre Dame, USA	PhD: Computer Science and Engineering
09/2016 – 06/2019	Huazhong University of Science &Technology, Wuhan, China	MS: Microelectronic and Solid-state Electronics
09/2012 – 06/2016	Huazhong University of Science &Technology, Wuhan, China	BS: Optoelectronic Information Engineering

EXPERIENCE

June – August 2021 (Consultant, Allen Institute)

- Although deep neural networks have shown great success in segmenting nucleus in 3D cell images, segmentation issue still may happen sometimes either because the model is not good enough or the test data is out of distribution from the training data. Hired as a consultant for Allen Institute, I investigate and compare multiple different uncertainty estimation methods to generate uncertainty map of the segmentation so that the experts can easily locate the segmentation error.
- I developed an automatic segmentation failure detection system by leveraging the uncertainty map generated above, the system can automatically tell which 3D cell images may have segmentation issue and where this issue occurs. This can not only benefit the machine learning people because we can use it to revise the label or add hard cases to the training data to improve the model, but also benefit the experimental people because we can identify out of distribution data and take necessary actions like redoing the cell imaging (Collaborator: Dr. Susanne Rafelski).

October 2020 – Present (Visiting Scientist, Boston Children's hospital/Harvard Medical School)

- I work as a visiting scientist in the Department of Cardiology at Boston Children's Hospital, the #1 children's hospital in US based on US News Ranking and a teaching hospital of Harvard Medical School. My responsibility involves building an AI framework to facilitate PICU operations. One interesting problem I am involved is to automatically extract information from multiple chest X-rays of the same patient in PICU taken at different time stamps so that doctors can monitor the health condition. These chest X-rays are highly temporal correlated. To leverage such information, I developed a contrastive learning framework to learn image level representations from unlabeled chest X-rays to improve the performance of lung and heart segmentation network with limited label. The framework is now under clinical trial (Collaborator: Prof. John N Kheir).

January 2020 – December 2020 (Research Assistant, University of Notre Dame)

- Development of a structural contrastive learning framework to learn representations from unlabeled medical images so that the learned network can perform better with limited labeled data. (Advisor: Prof. Yiyu Shi)
- Development of a real-time segmentation quality control framework to guide sonographers during ultrasound data acquisition, the system can help sonographers obtain high quality ultrasound videos with better segmentation results. (Advisor: Prof. Yiyu Shi)
- Development of a hardware-aware neural architecture search method to enable real-time 3D cardiac cine MRI segmentation. (Advisor: Prof. Yiyu Shi)
- Development of a segmentation network with temporal consistency for myocardial segmentation of contrast echocardiography. (Advisor: Prof. Yiyu Shi)

August 2019 – December 2019 (Teaching Assistant, University of Notre Dame)

- Development of a new segmentation metric to address the large intra- and inter-observer variability issue during network training and evaluation using myocardial contrastive echocardiography as a case example. (Advisor: Prof. Yiyu Shi)
- Teaching Assistant for Logic Design
- Teaching Assistant for Database.

August 2017 – June 2019 (Huazhong University of S&T)

- Designed a memristor-based high-throughput hardware acceleration framework to speed up the computation of distance function in data mining. (Advisor: Prof. Yu Hu)

AWARDS

- Top Winning Award, IEEE SERVICES Hackathon, 2020. One key problem of deploy DNN models to the real-world for secure medical image analysis is to handle data transfer and computation securely and efficiently. I led a team and designed blind U-Net for secure COVID-19 CT segmentation. We used a combination of cryptographic building blocks to ensure that the client-side encryption is enforced on all data related to the patients, and that practical inference time can also be achieved. See News Release here https://cse.nd.edu/news/notre-dame-team-shares-top-honors-in-ieee-services-2020-hackathon-for-project-related-to-covid-19-patient-data-privacy/
- Outstanding undergraduate, Qiming College, Huazhong University of Science and Technology, 2016
- Second prize, National Undergraduate Electronics Design Contest (NUEDC), 2015.

Proposal Writing

- "FAI: Addressing Fairness Issues in AI-Assisted Healthcare Mobile Apps through Unsupervised Federated Learning," National Science Foundation, 03/01/22-02/28/25, $1,000,000 (Pending)

  I drafted the tasks to be conducted at Notre Dame. Traditional federated learning usually aggregate multiple local models by averaging their weights, which may lead to severe fairness issues when data is unevenly distributed. We plan to solve this problem by introducing model contrastive to automatically adjust the aggregation weights so that the under representative model can contribute mode to the global model to improve model fairness. We also plan to use model personalization and personalization aware data labelling to effectively train a personalized model on each local client for inference/diagnosis.

- "Collaborative Research: CNS Core: Small: Towards Unsupervised Learning on Resource Constrained Edge Devices with Novel Statistical Contrastive Learning Scheme," National Science Foundation, 09/01/21-08/31/24, $250,000 (Funded)

  I drafted the tasks to be conducted at Notre Dame. We plan to explore the feasibility of integrating Independent Component Analysis (ICA) into the traditional contrastive learning framework to learn better feature image level representations as well as to reduce the memory and consumption and improve the learning speed.

- "RAPID: Collaborative Research: Independent Component Analysis Inspired Statistical Neural Networks for 3D CT Scan Based Edge Screening of COVID-19," National Science Foundation, 05/01/20-04/30/22, $98,349 (Funded)

  I helped shaping the project idea in response to the NSF DCL on COVID-19 and led the proposal writing for tasks to be carried out at Notre Dame. The project has received extensive global media coverage. For example, https://news.nd.edu/news/artificial-intelligence-could-improve-accuracy-efficiency-of-ct-screening-for-covid-19-diagnosis/,
  https://www.azorobotics.com/News.aspx?newsID=11531
  https://es.dotmed.com/news/story/52163
  https://health.economictimes.indiatimes.com/news/medical-devices/ai-can-improve-ct-screening-for-covid-19-diagnosis/77482680

- "Collaborative Research: CNS Core: Small: Intermittent and Incremental Inference with Statistical Neural Network for Energy-Harvesting Powered Devices," National Science Foundation, 10/01/20 – 09/30/23, $230,272 (Funded)

I drafted the tasks to be conducted at Notre Dame. We plan to develop a novel Multi-Exist Statistical and Incremental Neural Network (MESI-NN) to capture temporal correlation over multiple input instances and to handle them in one single pass to reduce minimum working energy. MESI-NN will also be extended to handle spatial correlations in a single instance to further reduce inference latency and boost energy efficiency.

PUBLICATIONS

1. **Dewen Zeng,** Mingqi Li, Yukun Ding, Xiaowei Xu, Qiu Xie, Ruixue Xu, Hongwen Fei, Meiping Huang, Jian Zhuang, and Yiyu Shi. "Segmentation with Multiple Acceptable Annotations: A Case Study of Myocardial Segmentation in Contrast Echocardiography." In International Conference on Information Processing in Medical Imaging (IPMI), pp. 478-491. Springer, Cham, 2021.
2. **Dewen Zeng,** Yawen Wu, Xinrong Hu, Xiaowei Xu, Haiyun Yuan, Meiping Huang, Jian Zhuang, Jingtong Hu, and Yiyu Shi. "Positional Contrastive Learning for Volumetric Medical Image Segmentation." in Proc. of Medical Image Computing and Computer Assisted Interventions (MICCAI), Strasburg, France, 2021 (early accept, acceptance rate 13%).
3. **Dewen Zeng**, John N Kheir, Peng Zeng and Yiyu Shi, "Contrastive Learning with Temporal Correlated Medical Images: A Case Study using Lung Segmentation in Chest X-Rays" in Proc. of IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2021 (acceptance rate 25%).
4. **Dewen Zeng**, Yukun Ding, Xiaowei Xu, Haiyun Yuan, Hongwen Fei, Meiping Huang, Jian Zhuang, Jingtong Hu and Yiyu Shi, "Hardware-aware Real-time Myocardial Segmentation Quality Control in Contrast Echocardiography," in Proc. of IEEE/ACM Design Automation Conference (DAC), 2021 (acceptance rate 22%).
5. **Dewen Zeng**, Weiwen Jiang, Tianchen Wang, Xiaowei Xu, Haiyun Yuan, Meiping Huang, Jian Zhuang, Jingtong Hu and Yiyu Shi, "Towards Cardiac Intervention Assistance: Hardware-Aware Neural Architecture Exploration for Real-Time 3D Cardiac Cine MRI Segmentation," in Proc. of IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2020 (acceptance rate 25%).
6. Yukun Ding, **Dewen Zeng**, Mingqi Li, Hongwen Fei, Haiyun Yuan, Meiping Huang, Jian Zhuang and Yiyu Shi, "Towards Efficient Human-Machine Collaboration: Real-Time Correction Effort Prediction for Ultrasound Data Acquisition," in Proc. of Medical Image Computing and Computer Assisted Interventions (MICCAI), Strasburg, France, 2021 (early accept, acceptance rate 13%)
7. Xinrong Hu, **Dewen Zeng**, Xiaowei Xu and Yiyu Shi, "Semi-supervised Contrastive Learning for Label-efficient Medical Image Segmentation," in Proc. of Medical Image Computing and Computer Assisted Interventions (MICCAI), Strasburg, France, 2021 (early accept, acceptance rate 13%)
8. Yawen Wu, **Dewen Zeng**, Zhepeng Wang, Yiyu Shi and Jingtong Hu, "Federated Contrastive Learning for Volumetric Medical Image Segmentation," in Proc. of Medical Image Computing and Computer Assisted Interventions (MICCAI), Strasburg, France, 2021 (early accept, acceptance rate 13%)
9. Yawen Wu, **Dewen Zeng**, Zhepang Wang, Yi Sheng, Lei Yang, and Alaina J James, Yiyu Shi, Jingtong Hu, "Federated Contrastive Learning for Dermatological Disease Diagnosis via On-device Learning," in Proc. of IEEE/ACM International Conference on Computer-Aided Design (ICCAD), 2021 (acceptance rate 25%).
10. Mingqi Li, **Dewen Zeng**, Xiaowei Xu, Qiu Xie, Ruixue Xu, Yu Wang, Yiyu Shi and Hongwen Fei, "A Deep Learning Approach with Temporal Consistency for Automatic Myocardial Segmentation of Quantitative Myocardial Contrast Echocardiography," The International Journal of Cardiovascular Imaging (2021): 1-12.
11. Yawen Wu, Zhepeng Wang, **Dewen Zeng**, Yiyu Shi and Jingtong Hu, "Enabling On-Device Self-supervised Contrastive Learning with Selective Data Contrast," in Proc. of IEEE/ACM Design Automation Conference (DAC), 2021 (acceptance rate 22%).
12. Lei Huang, Jiahua Li, Meiping Huang, Jian Zhuang, Haiyun Yuan, Qianjun Jia, **Dewen Zeng** et al. "Prediction of pulmonary pressure after Glenn shunts by computed tomography–based machine learning models." European Radiology 30, no. 3 (2020): 1369-1377.
13. Xiaowei Xu, Tianchen Wang, **Dewen Zeng**, Yiyu Shi, Qianjun Jia, Haiyun Yuan, Meiping Huang, and Jian Zhuang. "Accurate congenital heart disease model generation for 3d printing." In *2019 IEEE International Workshop on Signal Processing Systems (SiPS)*, pp. 127-130. IEEE, 2019.
14. Xiaowei Xu, Yu Hu, **Dewen Zeng**, Wenyao Xu, Feng Lin, Xinwei Yao and Yiyu Shi, "MDA: A Reconfigurable Memristor-based Distance Accelerator for Time Series Mining on Data Centers", IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems, 38(5): 785-797 (2019).
15. Xiaowei Xu, **Dewen Zeng**, Wenyao Xu, Yiyu Shi, Yu Hu, "An Efficient Memristor-Based Distance Accelerator for Time Series Data Mining on Data Centers", 54th Design Automation Conference (DAC), 2017 (acceptance rate 24%).

References

- **Yiyu Shi,**
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- **John N. Kheir,**
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- **Susanne Rafelski,**
  Ph.D., the Deputy Director, Allen Institute for Cell Science
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- **Jian Zhuang,**
  Professor, Guangdong Cardiovascular Institute, Guangdong Provincial People's Hospital
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