Lei Zhao

PhD Candidate in Computer Science

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Research

Hardware level: Computer architecture, Memory system, Emerging memory technology, Accelerator design

Software level: Deep learning, Secure and Privacy-preserving machine learning, Homomorphic encryption

Education

University of Pittsburgh — *Pittsburgh, PA, U.S.*
PH.D. CANDIDATE OF COMPUTER SCIENCE — *Aug. 2014 - Apr. 2022*
- Co-advised by Youtao Zhang and Jun Yang

Northwestern Polytechnical University — *Xi'an, Shaanxi, China*
MASTER OF COMPUTER SCIENCE — *Aug. 2011 - Apr. 2014*

Northwestern Polytechnical University — *Xi'an, Shaanxi, China*
BACHELOR OF SOFTWARE ENGINEERING — *Aug. 2007 - July. 2011*

Work Experience

Meta, Inc., USA — *Postdoc Research Scientist*
REALITY LABS — *Jan. 2022 - Present*
- Project related research.

National Key Lab of Process Optimization and Intelligent Decision, Ministry of Education, China — *Research Intern*
SMART MEDICAL SYSTEM TEAM — *Jul. 2018 - Aug. 2018*
- Designed a multimodal CNN model and used homomorphic encryption to protect user's privacy.
- One journal paper under submission.

National Key Lab of Process Optimization and Intelligent Decision, Ministry of Education, China — *Research Intern*
SMART MEDICAL SYSTEM TEAM — *Aug. 2017 - Sep. 2017*
- Developed a privacy-preserving neural network framework in C++ with CUDA acceleration.
- Published one journal paper in ACM Transactions on Internet Technology (TOIT).

Projects

Machine Learning Accelerators — *University of Pittsburgh*
DESIGNER AND CONDUCTOR — *Apr. 2017 - Present*
- Design ASIC accelerators based on existing or emerging memory technologies to improve performance and energy efficiency of machine learning computations with a focus on model security and user privacy.
- Three conference papers in [ICCAD'17] [ICS'19] [DAC'20] and one U.S. patent.

Privacy-Preserving Medical Data Analysis — *Hefei University of Technology*
RESEARCH ASSISTANT — *Aug. 2017 - Present*
- Evaluate Neural Networks on medical data with homomorphic encryption to protect patient's private information.
- One journal paper in ACM Transactions on Internet Technology (TOIT) and one journal paper under submission.

Privacy-Preserving Neural Network Framework *University of Pittsburgh*

Designer and Developer *Aug. 2017 - Sep. 2017*

- A neural network framework that targets at privacy-preserving and architecture research.
- Written in C++ and CUDA. Support fixed-point computing, stochastic-computing and homomorphic encryption.
- Open sourced on github: https://github.com/leizhaocs/ArchNet.

Emerging Memory Design *University of Pittsburgh*

Designer and Conductor *Sep. 2014 - Apr. 2016*

- Circuit level optimization of non-volatile memory for machine learning acceleration.
- Developed a cycle-accurate out-of-order architecture simulator based on MIPS ISA. Open sourced on github: https://github.com/leizhaocs/Monichi.
- Four conference papers in [ICCD'15] [ISQED'17] [NVMSA'17] [ICCAD'17] and one journal paper in IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems (TCAD).

Publications

Conference Proceedings

- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2022). A DNN Protection Solution for PIM Accelerators With Model Compression. IEEE Computer Society Annual Symposium on VLSI. (ISVLSI'22)
- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2022). SRA: A Secure ReRAM-Based DNN Accelerator. Design Automation Conference. (DAC'22)
- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2021). Flipping Bits to Share Crossbars in ReRAM-BasedDNN Accelerator. International Conference on Computer Design. (ICCD'21)
- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2020). SCA: A Secure CNN Accelerator for both Training and Inference. Design Automation Conference. (DAC'20)
- **Lei Zhao**, Quan Deng, Youtao Zhang, and Jun Yang. (2019). RFAcc: A 3D ReRAM Associative Array based Random Forest Accelerator. International Conference on Supercomputing. (ICS'19)
- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2017). AEP: An Error-bearing Neural Network Accelerator for Energy Efficiency and Model Protection. International Conference On Computer Aided Design. (ICCAD'17)
- Wen Wen, **Lei Zhao**, Youtao Zhang, and Jun Yang. (2017). Speeding Up Crossbar Resistive Memory by Exploiting In-memory Data Patterns. International Conference On Computer Aided Design. (ICCAD'17)
- **Lei Zhao**, Youtao Zhang, and Jun Yang. (2017). Mitigating Shift-Based Covert-Channel Attacks in Racetrack Last Level Caches. Non-Volatile Memory Systems and Applications Symposium. (NVMSA'17)
- **Lei Zhao**, Lei Jiang, Youtao Zhang, Nong Xiao, and Jun Yang. (2017). Constructing Fast and Energy Efficient 1TnR based ReRAM Crossbar Memory. International Symposium on Quality Electronic Design. (ISQED'17)
- Xianwei Zhang, **Lei Zhao**, Youtao Zhang, and Jun Yang. (2015). Exploit Common Source-Line to Construct Energy Efficient Domain Wall Memory based Caches. International Conference on Computer Design. (ICCD'15)

Journal Articles

- Zijie Yue, Shuai Ding, **Lei Zhao**, Youtao Zhang, Zehong Cao, M. Tanveer, Alireza Jolfaei, and Xi Zheng. (2020). Privacy-preserving Time Series Medical Images Analysis Using a Hybrid Deep Learning Framework. ACM Transactions on Internet Technology.
- Wen Wen, **Lei Zhao**, Youtao Zhang, and Jun Yang. (2019). Exploiting In-memory Data Patterns for Performance Improvement on Crossbar Resistive Memory. IEEE Transactions on Computer-Aided Design of Integrated Circuits and Systems.

Patents

- Youtao Zhang, **Lei Zhao**, and Jun Yang. (2019). System and method of deploying an artificial neural network on a target device. U.S. Patent, US20190147344A1.

– Shuai Ding, **Lei Zhao**, Shanlin Yang, Hao Wang and Zijie Yue. (2020). The architecture, image processing method and process of an artificial intelligence chip for medical endoscope. Chinese. Patent, CN108055454B.

Skills

Programming C/C++, Python, Java, CUDA
Algorithms Deep Learning, Reinforcement Learning, Homomorphic Encryption
Tools Gem5, DRAMSim2, numpy, PyTorch, Homomorphic Encryption Libraries(SEAL, HEAAN), Linux/Unix

Honors & Awards

2021 **Best Paper Candidate**, 39th International Conference on Computer Design (ICCD) — *Virtual Conference*

2017 **Best Paper Candidate**, 18th International Symposium on Quality Electronic Design (ISQED) — *Santa Clara, CA, USA*

2014 **Outstanding Master Degree Thesis**, Graduation Commencement of Northwestern Polytechnical University — *Xi'an, Shaanxi, China*