

# 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

PH.D. CANDIDATE OF COMPUTER SCIENCE

- Co-advised by Youtao Zhang and Jun Yang

*Pittsburgh, PA, U.S.*

*Aug. 2014 - July. 2021 (expected)*

### Northwestern Polytechnical University

MASTER OF COMPUTER SCIENCE

*Xi'an, Shaanxi, China*

*Aug. 2011 - Apr. 2014*

### Northwestern Polytechnical University

BACHELOR OF SOFTWARE ENGINEERING

*Xi'an, Shaanxi, China*

*Aug. 2007 - July. 2011*

## Work Experience

### National Key Lab of Process Optimization and Intelligent Decision, Ministry of Education, China

SMART MEDICAL SYSTEM TEAM

*Research Intern*

*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

SMART MEDICAL SYSTEM TEAM

*Research Intern*

*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

DESIGNER AND CONDUCTOR

*University of Pittsburgh*

*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

RESEARCH ASSISTANT

*Hefei University of Technology*

*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

DESIGNER AND DEVELOPER

*University of Pittsburgh*

*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

DESIGNER AND CONDUCTOR

University of Pittsburgh

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. (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

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*