Haiyu Mao

Postdoctoral Researcher at ETH Zurich

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Research Interests

My research interests are in the intersection between **computer architecture**, **memory systems**, **processing-in-memory (PIM)**, **processing-in-storage (PIS)**, **bioinformatics**, and **machine learning**, mainly including:

- Full-stack acceleration for bioinformatics and machine learning applications via software-and-hardware co-design that explores a large design space to maximize benefits.
- Heterogeneous data-centric architecture that orchestrates advanced microarchitectures (e.g., NVM-based PIMs for string matching and vector-matrix multiplication operations, PIS microarchitectures, etc.) to harness the unique strengths of the microarchitectures.

Education

Aug. 2015 - Jul. 2020	**Tsinghua University**, Beijing, China Ph.D. in Computer Science (Advisor: Prof. Jiwu Shu) Dissertation Title: *Processing in Non-Volatile Memory for Machine Learning Applications* Outstanding Ph.D. Graduate in Beijing
Aug. 2011 - Jul. 2015	**Northeastern University**, Shenyang, China B.S. in Software Engineering (Rank: 1/201)

Professional Work Experience

Jul. 2020 - Now	**ETH Zurich** Senior Researcher & Teaching Assistant in SAFARI Research Group Advisor: Prof. Onur Mutlu
May. 2021 - Now	**ETH Future Computing Laboratory (EFCL)** Group Associate Group Manager: Dr. Andrea Cossettini
Mar. 2015 - Sept. 2017	**Peking University** Research Intern Mentor: Prof. Guangyu Sun

Selected Honors & Awards

2020	**Outstanding Ph.D. Graduate in Beijing**, Top 5 in the department	*Beijing, China*
2019	**National Scholarship for Ph.D.**, 2.5% of the Ph.D. students at Tsinghua	*Beijing, China*
2015	**Scholarship Funded by The Mayor of Shenyang**, Top 6 in Northeastern University	*Shenyang, China*
2014	**Top 10 Excellent Undergraduates**, Top 10 in Northeastern University	*Shenyang, China*
2014	**Outstanding Undergraduate in Shenyang**, 0.26% of undergraduates	*Shenyang, China*
2012/2013/2014	**Outstanding Pioneer Student**, 0.5% of students at Northeastern University	*Shenyang, China*
2012/2013/2014	**National Scholarship**, 1% of students at Northeastern University	*Shenyang, China*

Publications

[MICRO 2023] Taha Shahroodi, Gagandeep Singh, Mahdi Zahedi, **Haiyu Mao**, Joel Lindegger, Can Firtina, Stephan Wong, Onur Mutlu, and Said Hamdioui, "SwordFish: A Framework for Evaluating DNN-based Basecalling using Computation-In-Memory with Non-Ideal Memristors", in *International Symposium on Microarchitecture*, October 2023.

[Bioinformatics 2023] Can Firtina, Nika Mansouri Ghiasi, Joel Lindegger, Gagandeep Singh, Meryem Banu Cavlak, **Haiyu Mao**, and Onur Mutlu, "RawHash: Enabling Fast and Accurate Real-Time Analysis of Raw Nanopore Signals for Large Genomes", in *Intelligent Systems for Molecular Biology / European Conference on Computational Biology*, July 2023.

[ISCA 2023] Rakesh Nadig, Mohammad Sadrosadati, **Haiyu Mao**, Nika Mansouri Ghiasi, Arash Tavakkol, Jisung Park, Hamid Sarbazi-Azad, Juan Gómez Luna, and Onur Mutlu, "Venice: Improving Solid-State Drive Parallelism at Low Cost via Conflict-Free Accesses", in *International Symposium on Computer Architecture*, June 2023.

[MICRO 2022] **Haiyu Mao**, Mohammed Alser, Mohammad Sadrosadati, Can Firtina, Akanksha Baranwal, Damla Senol Cali, Aditya Manglik, Nour Almadhoun Alserr, and Onur Mutlu, "GenPIP: In-Memory Acceleration of Genome Analysis by Tight Integration of Basecalling and Read Mapping", in *International Symposium on Microarchitecture*, October 2022.

[CSBJ 2022] Mohammed Alser, Joel Lindegger, Can Firtina, Nour Almadhoun, **Haiyu Mao**, Gagandeep Singh, Juan Gomez-Luna, and Onur Mutlu, "From Molecules to Genomic Variations: Accelerating Genome Analysis via Intelligent Algorithms and Architectures", in *Computational and Structural Biotechnology Journal*, August 2022.

[ASPLOS 2022] Nika Mansouri Ghiasi, Jisung Park, Harun Mustafa, Jeremie Kim, Arvid Gollwitzer, Ataberk Olgun, **Haiyu Mao**, Can Firtina, Damla Senol Cali, Nour Almadhoun Alserr, Rachata Ausavarungnirun, Nandita Vijaykumar, Mohammed Alser, and Onur Mutlu, "GenStore: An In-Storage Processing System for Genome Sequence Analysis", *in ACM International Conference on Architectural Support for Programming Languages and Operating Systems*, March 2022.

[TC 2021] **Haiyu Mao**, Jiwu Shu, Mingcong Song, and Tao Li, "LrGAN: A Compact PIM-based GAN Architecture with Low Energy Consumption", in *IEEE Transactions on Computers*, 2021.

[SSI 2020] **Haiyu Mao**, Jiwu Shu, Fei Li, and Zhe Liu, "The Development of Processing In Memory", in *SCIENTIA SINICA Informationis* (In Chinese), 2020.

[TOS 2020] Fan Yang, Youmin Chen, **Haiyu Mao**, Youyou Lu, and Jiwu Shu, "Libra: An Efficient and Fast Recoverable System for Secure Non-Volatile Memory", in *ACM Transactions on Storage*, 2020.

[JCRD 2019] **Haiyu Mao** and Jiwu Shu, "3D Memristor Array Based Neural Network Processing in Memory Architecture", in *Journal of Computer Research and Development,* (In Chinese), 2019.

[DAC 2019] Fan Yang, Youyou Lu, Youmin Chen, **Haiyu Mao**, and Jiwu Shu, "No Compromises: Secure NVM with Crash Consistency, Write-Efficiency, and High-Performance", in *Design Automation Conference*, June 2019.

[MICRO 2018] **Haiyu Mao**, Mingcong Song, Tao Li, Yuting Dai, and Jiwu Shu, "LerGAN: A Zero-Free, Low Data Movement and PIM-Based GAN Architecture", in *International Symposium on Microarchitecture*, October 2018.

[DATE 2017] **Haiyu Mao**, Xian Zhang, Guangyu Sun, and Jiwu Shu, "Protect Non-Volatile Memory from Wear-Out Attack Based on Timing Difference of Row Buffer Hit/Miss", in *Conference on Design, Automation & Test in Europe*, March 2017.

[NVMSA 2015] **Haiyu Mao**, Chao Zhang, Guangyu Sun, and Jiwu Shu, "Exploring Data Placement in Racetrack Memory Based Scratchpad Memory", in *Non-Volatile Memory System and Applications Symposium*, August 2015.

Paper under Submission

[ASPLOS 2024] **Haiyu Mao**, Mohammad Sadrosadati, Can Firtina, Melina Soysal, Nika Mansouri Ghiasi, Meryem Banu Cavlak, Taha Shahroodi, Rakesh Nadig, and Onur Mutlu, "Title is hidden for the double-blinded review", submitted to ACM International Conference on Architectural Support for Programming Languages and Operating Systems, August 2023.

[HPCA 2024] Nika Mansouri Ghiasi, Mohammad Sadrosadati, Harun Mustafa, Arvid Gollwitzer, Can Firtina, Julien Eudine, **Haiyu Mao**, Joël Lindegger, Meryem Banu Cavlak, Mohammed Alser, Jisung Park, and Onur Mutlu, "Title is hidden for the double-blinded review", submitted to IEEE International Symposium on High-Performance Computer Architecture, August 2023.

Teaching Experience

2020 - Now **Computer Architecture** (Fall, Master-level course), *ETH Zurich*
Guest Lecturer & Teaching Assistant

2021 - Now **Digital Design and Computer Architecture** (Spring, Bachelor-level course), *ETH Zurich*
Guest Lecturer & Teaching Assistant

2020 - Now **Seminar in Computer Architecture** (Fall and Spring, Bachelor-level course), *ETH Zurich*
Mentor & Teaching Assistant

2022 - Now **P&S Genomics** (Fall and Spring, All-level course), *ETH Zurich*
Mentor & Guest Lecturer

2021 - 2022 **P&S Processing-in-Memory** (Fall and Spring, All-level course), *ETH Zurich*
Mentor

2021 - 2022 **P&S Software-and-Hardware Co-design** (Fall and Spring, All-level course), *ETH Zurich*
Mentor

2016 - 2019 **Storage System** (Fall, Master/Ph.D.-level course), *Tsinghua University*
Teaching Assistant

Mentoring Experience

2023 - Now **Qingcai Jiang** (ETH Zurich, Visiting Student)
Flexible and Unified Processing-in-Memory System

2023 - Now **Yintao He** (ETH Zurich, Visiting Student)
Processing-in-Memory System for Large Language Models

2023 - Now **Melina Soysal** (ETH Zurich, Visiting Student)
Processing-in-Storage System for Raw-Signal Genome Analysis

2023 Spring **Özcan Mulaimi** (ETH Zurich, Bachelor Student)
Seed-and-Vote Algorithm for Raw-Signal Genome Analysis

2021 - Now **Aditya Manglik** (ETH Zurich, Master Student)
Flexible Non-Volatile Memory-based Processing-in-Memory System for Neural Networks

2021 - 2022 **Akanksha Baranwal** (ETH Zurich, Master Student)
Processing-in-Memory System for the Basecalling in Genome Analysis

2019 - 2020 **Jing Wang** (Tsinghua University, Ph.D. Student)
Processing-in-Memory Systems for Machine Learning Applications

2017 - 2020 **Fan Yang** (Tsinghua University, Ph.D. Student)
Secure Non-Volatile Memory Systems

Research Funding

2023 - 2024 **ETH Future Computing Laboratory: Blended-Project Funding (PI: Haiyu Mao)**, 80,000 CHF
Project Title: Processing-in-Memory Acceleration for Raw-Signal Genome Analysis

Invited Talks & Posters

Processing-in-Memory for Genome Analysis
at PIM Workshop in Beijing, 2023, Online

GenPIP: In-Memory Acceleration of Genome Analysis via Tight Integration of Basecalling and Read Mapping
at MICRO, 2022, Chicago, IL
at RECOMB BioArch Workshop, 2023, Online
at SAFARI Live Seminar, 2023, ETH Zurich
at Computer Architecture Courses, 2023, ETH Zurich
Poster at London Calling, 2023, Online

LerGAN: A Zero-Free, Low Data Movement, and PIM-Based GAN Architecture
at MICRO, 2018, Fukuoka, Japan

Protect Non-Volatile Memory from Wear-Out Attack Based on Timing Difference of Row Buffer Hit/Miss
at DATE, 2017, Lausanne, Switzerland

Professional Service

Technical Program Committee (TPC) Member
Design, Automation and Test in Europe Conference (DATE), 2022

Technical Reviewer for Journals
ACM Computing Surveys, IEEE Micro, IEEE Transactions on Computers (TC)

Technical Assistant-Reviewer for Conference
ISCA, MICRO, HPCA, ASPLOS, DSN

Co-lead of Emerging Technology and Application Meeting
SAFARI Research Group, ETH Zurich

Reference

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Professor, Department of Computer Science and Technology, Tsinghua University
Dean, School of Information, Xiamen University
President, Minjiang University
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