

GELIN FU

Xi'an Jiaotong University No.28 Xianning West Road, Xi'an 710049, China
(+86)15723090881 ◇ fugelin@stu.xjtu.edu.cn

EDUCATION

Xi'an Jiaotong University

September 2019-present

Ph.D. Candidate in Control Science and Engineering

Advisor: Prof. Pengju Ren

Chongqing University

September 2015-June 2019

B.E. in Automation

Overall GPA: 3.85/4.00, ranking 2/208

AREA OF INTEREST

- Performance modeling and optimization of graph applications
- Novel computer architecture for emerging applications

EXPERIENCE

Data prefetcher for irregular workloads

January 2022 - April 2023

Project Leader

Modern CPUs are memory-bounded for graph analysis, sparse linear algebra, and many other applications. During this research, my contributions include:

- Proposing a novel hardware data prefetcher for irregular workloads targeting indirect memory access pattern.
- Performing extensive evaluations on high-end ARM CPUs with standard benchmarks to show that our prefetcher outperforms state-of-art approaches, achieving average **2.1x** over no prefetching baseline and **1.8x** over the best existing approach.

Modeling and optimization of SpMV kernel

January 2021 - December 2021

Project Leader

Sparse Matrix-Vector Multiplication (SpMV) is one of the most commonly-used computation kernels in domains of scientific and industrial applications. During this research, my contributions include:

- Studying SpMV kernels on out-of-order CPUs with extensive experiments and identifying the key software and hardware factors that should be specially considered by using the GEM5 simulator.
- Establishing a performance model that efficiently represents the influence and interaction of multiple factors, and provides insights of SpMV execution.
- Proposing a novel SpMV kernel that effectively improves computation density and branch prediction, boosting MLP to **2.3x**.
- Performing extensive evaluations on main-stream high-end Intel and ARM CPUs with standard benchmarks to show that our model is reasonably built and our new SpMV kernel outperforms state-of-the-art approaches, achieving average **3.4x** over Intel Math Kernel Library and **1.4x** over the best existing approach.

Instruction cache design and memory system verification

December 2019 - October 2020

Major Participant

Hybrid Intelligence Processing Unit(HiPU) is a deep learning algorithm accelerator for edge computing based on RISC-V architecture with extended instructions of NPU operations. During this project, my contributions include:

- Designing the instruction cache with stream buffer to perform next-line prefetching by using System Verilog.
- Characterizing the behavior of cache system and writing test cases to verify cache system correctness by using VCS tool.
- Modeling the behavior of Load-Store Unit and writing test cases to verify memory access behavior correctness.

TECHNICAL SKILLS

Computer Architecture	X86, ARM, RISC-V
Programming Framework	OpenMP, AVX, SVE
Computer Languages	System Verilog, Assembly language, C, C++, Python
Simulators	GEM5, QEMU
Tools	Vivado, VCS, Verdi, Perf
Language	Proficient in written and spoken English

PUBLICATIONS

- **Gelin Fu***, Tian Xia*, Ruiyang Chen, Zhongpei Luo, Wenzhe Zhao, Nanning Zheng, Pengju Ren “Differential- Matching Prefetcher for Indirect Memory Access”, Proceedings of IEEE/ACM International Symposium on High-Performance Computer Architecture, 2024(accepted).
- **Gelin Fu**, Tian Xia, Shaoru Qu, Zhongpei Luo, Shuyu Li, Pengyv Cheng, Runfan Guo, Yitong Ding, Pengju Ren “PrSpMV: An Efficient Predictable Kernel for SpMV”, IEEE International Conference on Computer Design, 2023(accepted).
- Tian Xia*, **Gelin Fu***, Chenyang Li, Luzheng Zhang, Ruiyang Chen, Zhongpei Luo, Wenzhe Zhao, Nanning Zheng, Pengju Ren “A Comprehensive Performance Model of Sparse Matrix-Vector Multiplication to Guild Optimization”, IEEE Transactions on Parallel and Distributed Systems(TPDS), 2022(accepted).
- Tian Xia, Boran Zhao, Jian Ma, **Gelin Fu**, Nanning Zheng, Pengjun Ren “ An Energy-and-Area-Efficient CNN Accelerator for Universal Powers-of-Two Quantization”, IEEE Transactions on Circuits and Systems I: Regular Papers, 2023(accepted).

HONORS

- National Scholarship, ranking 1/208, 2016
- Second prize at the provincial level in the Chinese Mathematics Competitions, 2016
- School Outstanding Student in Chongqing University, 2018
- Rising star of Institute of Artificial Intelligence and Robotics, 2023