Muchen Xu

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RESEARCH INTEREST

Compiler Optimizations, Automated Optimized Code Generation, Performance Engineering, Formal Semantics and Program Synthesis

ACADEMIC HISTORY

University of Illinois, Urbana-Champaign, IL, U.S. December 2023 (expected)
M.S. in Computer Science
Cumulative GPA: 4.00/4.00
Course Work: Advanced CUDA kernel programming, Advanced Compiler Design, OS Design, Interactive Computer Graphics, Compiler Seminar, Program Verification.

University of Michigan, Ann Arbor, MI, U.S. August 2020 – April 2022
B.S. in Engineering in Computer Sci., Major in Computer Science, Minor in Mathematics
Cumulative GPA: 4.00/4.00
Course Work: Algorithm & Data Structure, Computer Organization, Operating System, Cryptography, Compiler, Computer Security, Network, Web, Computer Vision.

Shanghai Jiao Tong University, Shanghai, China Sept 2018 – August 2022
B.S. in Electric and Computer Engineering
Honor: The Yu Liming Scholarship (2019), SJTU Rongchang Scholarship (2020,2021)

RESEARCH EXPERIENCE

Illinois LLVM Compiler Research Lab *Research Assistant,* May 2023 – Present
Supervisor: Prof. Vikram S. Adve; Close Collaborators: Prof. Charith Mendis and Dr. Sudipta Sengupta

- Involving development of a synthesis-based code generation framework for modern hardware architectures in Halide called Hydride (published at ASPLOS 2024) and in MLIR called AutoMLIR.
- Leading the development of AutoMLIR that target at the GPUs for Intel.

PUBLICATIONS AND MANUSCRIPTS

- Akash Kothari, Abdul Rafae Noor, **Muchen Xu**, Hassam Uddin, Dhruv Baronia, Stefanos Baziotis, Vikram Adve, Charith Mendis, Sudipta Sengupta. “Hydride: A Synthesis-based Retargetable Code Generation Framework for Modern Hardware Architectures”. Published at ASPLOS 2024.
- **Muchen Xu**, Zhang Lan, Jiaai Xu, Yanlong Yao, Steven Lumetta. “Aho-Corasick Algorithm on GPGPU”. (In progress)

TECHNICAL REPORTS

- **Muchen Xu**, Yanlong Yao, José Meseguer. “Case Study in NuITP, An Interactive Inductive Theorem Prover”, Technical Report, December 2022.
- **Muchen Xu,** Shixin Song, Yuxuan Cao, Mahdi Cheraghchi. “Lenstra-Lenstra-Lovasz Reduction Attacks in Cryptography”, Technical Report, April 2021.

TALKS

University of Illinois Compiler Seminar Oct 2023
Hydride: A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures

- Introduced Hydride to system people at UIUC.
- Demonstrated the intermediate input and output pairs at each stage.
- Illustrated some of highlighted synthesis cases.

RESEARCH PROJECTS

Intel-GPU MLIR Project Sept 2023 – Present

- Parse Intel GPU VISA's semantics and automatically generate 1152 formally defined intrinsics.
- Lower the DSL program to SPIRV via MLIR and then optimize using synthesizer.

Hydride: A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures May 2023 – Aug 2023

- Sort out and compile 1500+ ARM NEON intrinsics as executable formal semantics in Rosette.
- Use Rosette to synthesize program with generated IR serving as vector code generation.
- Kernel performance outperform LLVM codegen by 1.26x and Halide codegen by 1.03x.
- Parallelize the engine which saves 91% of offline time. Make it faster for test and development.

INTERNSHIPS

Naive Systems *Compiler Engineer,* Dec 2022 – Mar 2023

- Use Clang static analyzer to perform path-sensitive analysis to detect potential weaknesses in C source code. Implement checkers for CWE (Common Weakness Enumeration)-170 (Improper Null Termination), CWE-124 (Buffer Underwrite), CWE-127 (Buffer Under-read) and CWE-789 (Memory Allocation with Excessive Size Value)
- Use Clang AST Matcher to perform syntax related analysis checking Google C++ Style Guide conformance.

Tencent Keen Security Lab *Software Analyzer,* May 2021 – Aug 2021

- Develop fuzzer for TLS protocol server, supporting TLS v1.2 and v1.3, with session resumption and secure negotiation extension implemented.
- Achieve 17.8% code coverage for OpenSSH-Server source code tested as benchmark.

ByteDance Ltd. *TikTok-iOS Developer,* Jan 2021 – Apr 2021

- Develop basic features, i.e., to limit the size of a feature sticker to prevent video stealing.
- Add client-side trackers that helps to verify the relevance of played videos and creation impulse.
- Fix UI bugs caused by calculation errors.
- Perform file-level static dependency analysis on repository code to help measure the amount of work required to access or sink a particular component into the middle platform.
- Perform symbol-level static analysis of repository code, combined with Louvain algorithm, to partition modules for complex file dependency networks.

TEACHING EXPERIENCE

EECS 376: Foundations of Computer Science, Ann Arbor *Grader,* Sept 2021 – Dec 2021

VG101: Intro to Computer & Programing, Shanghai *Teaching Assistant,* May 2020 – Aug 2020

- Serve as Lab Director, responsible for design lab contents and lead lab sessions.
- Assist the instructor in teaching and answering questions in class.
- Provide problem set for homework exams with delicately designed problems.

Shanghai Luogu Network Technology Co., Ltd., Shanghai *Instructor,* June 2018 – Aug 2020

- Give lectures about combinatoric math and number theory. Provide 10+ contest problems.
- Compile a guidebook for beginners in competitive programming. Sold 30,000+ copies in China.

NOTABLE HONORS & AWARDS

- Fall CTF (Capture-the-flag, cybersecurity competition): Ranked 5th out of 160 teams — Sept 2023
- Fall CTF 2022: Ranked 10th as solo player against 2-teamed players — Nov 2022
- James B. Angell Scholarship of University of Michigan — Mar 2022
- The Rongchang Scholarship of SJTU for 2021-2022 academic year — Nov 2021
- DEF CON 29 CTF Winner Team (as Katzebin) — Aug 2021
- The Rongchang Scholarship of SJTU for 2020-2021 academic year — Nov 2020
- 2020 SJTU-CTF 3rd place, Special Award: **1st place in Crypto**, 2nd place in **Reverse** — Oct 2020
- The Yuliming Scholarship of UM-SJTU Joint Institute for 2019-2020 academic year — Nov 2019
- 2019 SJTU-CTF Special Award: **2nd place in Cryptography**, 3rd place of Sophomore — Oct 2019
- 2018 ACM-ICPC Qingdao Site **Gold Medal** — Nov 2018
- 2018 CCPC Qinhuangdao Site **Gold Medal/ 2nd place** — Oct 2018
- 2018 ACM-ICPC Xuzhou Site **Gold Medal/ 3rd place** — Oct 2018

SKILLS & CERTIFICATIONS

- **Skills:**
  - ✧ Programming Language: C, C++, Python, Go, Rust, Bash, Racket, Rosette, CUDA, Z3, HTML, JavaScript, CSS, React, Java, Kotlin, Objective-C, Swift, Verilog, SQL, x86, ARM, RISC-V, Sage.
  - ✧ Compiler infrastructure: LLVM, MLIR, Halide, Bison, Yacc, Clang-Static-Analyzer
  - ✧ Binary Exploitation & Reversing: IDA, Ghidra, gdb+pwndbg, pwntools
  - ✧ More than 10 years' experience in data structure, algorithms, and code optimization
  - ✧ Codeforces Rating: 2126, Master
- **Course Projects:**
  - ✧ A remote robotic rover that can trace certain object powered by Raspberry Pi (SU 2019)
  - ✧ Thread library, pager, file system for operating system design (WN 2020)
  - ✧ Compilers for a course-defined functional PL (FA 2021) and OOP PL (FA 2022)
  - ✧ Interactive web services with React front-end and Flask back-end (FA 2021)
  - ✧ A note manager app based on augmented reality for Android (WN 2022)
  - ✧ A 32-bit, three-way superscalar pipelined processor in SystemVerilog (SU 2022)
  - ✧ LLVM optimization passes from scratch, including Loop-Invariant Code Motion and Sparse Conditional Constant Propagation (FA 2022)
  - ✧ CUDA tensor convolution with kernel fusion and register-tiling. Ranked 1st among 250+.
  - ✧ Rasterization on CPU and Raytracer optimized with bounding volume hierarchy (SP 2023)
  - ✧ Implement xv6, following labs from MIT online resource 6.S081 (SP2023)
  - ✧ Parallelize Aho-Corasick Algorithm on GPU. Outperform SOTAs by 5.18x. (SP2023)
  - ✧ Periodic task scheduler as kernel module for Linux (FA 2023)

REFERENCES

Prof. Vikram S. Adve
Donald B. Gilles Professor
Department of Computer Science, UIUC
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Prof. Charith Mendis
Assistant Professor
Department of Computer Science, UIUC
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