Computer Science Department
University of Illinois at Urbana-Champaign
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Abdul Rafae Noor

Education

2020–Present **University of Illinois at Urbana-Champaign**, *Urbana*, IL
PhD in Computer Science
Advisor: Vikram Adve
University of Illinois at Urbana-Champaign, *Urbana*, IL
Masters in Computer Science
Advisor: Vikram Adve

2016–2020 **Lahore University of Management Sciences**, *Lahore*, Pakistan
Bachelor of Science in Computer Science

Experience

May - Sept 2024 **Deep Learning Compiler Intern**, *NVIDIA Corporation*, Santa Clara, CA, USA
Fused kernel generation using compiler technologies for future NVIDIA architectures. GPU performance analysis using various public and private analysis tools.

2020-Present **Graduate Research Assistant**, *University of Illinois at Urbana-Champaign*, Urbana, IL, USA

Research Areas

- Compilers
- Vectorization
- Program Synthesis
- Performance Cost Models

Impact

- Developed the code synthesizer generator for our tool **Hydride: A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures**. Automatically generated compiler support for targetting X86 VNNI, SSE, AVX, AVX512, Hexagon HVX, and ARM using a program synthesis based approach. Additionallty integrated Hydride into Halide DSL compiler, where we acheived a 9% speed up over Halide's existing handwritten code generator. On going effort to support AMX.
- Automatically generating MLIR Dialect lowering support for vector and tensor backend architectures using MLIR (AutoMLIR). In progress
- Extending **Hydride** for compiling for Processing in Memory (PIM) architectures. Modelling data-movement, layout optimizations, and ISEL. In progress
- Collaboration with Intel, Qualcomm, IBM and Amazon in extending LLVM compiler with a re-targetable Tensor type. Project titled Tensor LLVM Extensions (TLX). Integrating TLX into Tensorflow's XLA to compile models such as BERT via our extensions.
- Contributed to open source release of the HPVM Project v1.0 and v2.0. Lead the creation and development of Hetero-C++, a parallel C++ dialect for targeting Heterogenous systems consisting of CPU's, GPU's, and FPGA's. Hetero-C++ and HPVM are actively used by IBM Research and academic research groups. This project was part of the DARPA Efficient Programmability of Cognitive Heterogeneous Systems (EPOCHS) project
- Extending HPVM for Hyper Dimensional Computing (HDC) application domain. Extensions to Hetero-C++ for HDC using higher level intrinsics. Intrinsics are compiled to CPU's, GPU's, FPGA's with various forms of parallelism. Compiling to HDC accelerators in progress.

Publications

Selected Conference Papers

[ASPLOS 2024] Akash Kothari*, **Abdul Rafae Noor*** , Hassam Uddin, Dhruv Baronia, Vikram Adve, Charith Mendis, Sudipta Sengupta . *Hydride:* A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures. (* equal contribution.)

[In Submission] Russel Arbore*, Xavier Routh*, **Abdul Rafae Noor** , Akash Kothari, Haichao Yang, Weihong Xu, Sumukh Pinge, Minxuan Zhou, Vikram Adve, Tajana S Rosing ß. *HPVM-HDC*: A Heterogeneous Programming System for Hyperdimensional Computing . (* equal contribution.)

Journal Publication

[TSE'22] Aatira Anum Ahmad, **Abdul Rafae Noor**, Hashim Sharif, Usama Hameed, Shoaib Asif, Mubashir Anwar, Ashish Gehani, Fareed Zaffar, and Junaid Haroon Siddiqui. TRIMMER: An Automated System for Configuration-based Software Debloating. *IEEE Transactions on Software Engineering (TSE'22)*.

[IEEE Micro'22] Adel Ejjeh, Aaron Councilman, Akash Kothari, Maria Kotsifakou, Leon Medvinsky, **Abdul Rafae Noor**, Hashim Sharif, Yifan Zhao, Sarita Adve, Sasa Misailovic, Vikram Adve. HPVM: Hardware-Agnostic Programming for Heterogeneous Parallel Systems. (*IEEE Micro'22*).

Course Projects

- **HPVM2WASM: Heterogenous Compilation for the Web**. Developed a WASM and WebGPU compiler backend and runtime for targetting CPU's and GPU's.
- **Explanation Augmented Compiler Performance Model**. Extended an existing Basic Block throughput ML Cost model to additionally **explain** throughput prediction by additionally providing explanation using Intel's microarchitecture performance counters. Required creating new dataset with labled explanations.
- **AutoHPVM**. Automatic Heterogenous Parallelization for C/C++ programs using the HPVM Compiler. Performs interprocedural analyses and loop dependence analyses to partition application into task-level and data-level parallelism. Uses HPVM compiler to compile for CPU, GPU, and FPGA's.

Languages and Frameworks

[Program Analysis] LLVM, MLIR, Clang, Soot, XLA (Tensorflow), ONNX, TOSA , PyTorch, Halide, Triton, Nsight-Systems, Nsight-compute

[Programming Languages] C/C++, CUDA,GoLang, Rust, Haskell, Lisp, NodeJS, Python, Rosette, Racket, OpenMP ,Prolog, SQL, R, Matlab, Swift

[Program Synthesis] Rosette, Z3

[Utilities] Docker, Vim, SSH, Bash Scripting, Make, CMake, Git, Bazel

Talks

- **NVIDIA Summer 2024 Internship Final Presentation**
  - Internal Talk at NVIDIA, 09/2024, Santa Clara, CA
  - Fused kernel generation using compiler technologies for future NVIDIA architectures.

- **Performance Analysis for NVIDIA architectures**
  - Internal Talk at NVIDIA, 09/2024, Santa Clara, CA
  - Presented a tutorial on using internal novel performance analysis tools at NVIDIA for future NVIDIA architectures.
- **Hydride: A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures**
  - Talk at NVIDIA, 07/2024, Santa Clara, CA
  - Attended by members from both the production and research teams
- **Compiler and Programming Language Techniques for Highly Programmable Data-Centric Computing Systems**
  - Talk at PRISM SRC Annual Review, 11/2023, San Diego
  - Additional demo and poster session
- **Hydride: A Retargetable and Extensible Synthesis-based Compiler for Modern Hardware Architectures**
  - Talk at Qualcomm, 05/2022, Virtual
  - Attended by members from both the production and research teams
- **TRIMMER: An Automated System for Configuration-based Software Debloating**
  - UIUC Compiler Seminar, 04/18/2022, University of Illinois

Honors and Awards

Student Travel Grant

2024 ACM International Conference on Architectural Support for Programming Languages and Operating Systems 2024

Sohaib And Sara Abbasi Computer Science Fellowship

2024 - Present University of Illinois, Urbana Champaign

Sohaib And Sara Abbasi Computer Science Fellowship

2023-2024 University of Illinois, Urbana Champaign

Sohaib And Sara Abbasi Computer Science Fellowship

2022-2023 University of Illinois, Urbana Champaign

Sohaib And Sara Abbasi Computer Science Fellowship

2021-2022 University of Illinois, Urbana Champaign

Sohaib And Sara Abbasi Computer Science Fellowship

2020-2021 University of Illinois, Urbana Champaign

Dean's Honor List

2018-2019 Lahore University of Management Sciences

Dean's Honor List

2017-2018 Lahore University of Management Sciences

Dean's Honor List

2016-2017 Lahore University of Management Sciences

Outstanding Cambridge Learner Award

2016 Cambridge International Examination 2nd Best across 3 A-level

Services

Spring 2022 UIUC Compiler Seminar - *Student Organizer*

Fall 2021 UIUC Compiler Seminar - *Student Organizer*

Teaching

Teaching Assistant

Spring 2023 UIUC CS 173 Discrete Structures

Teaching Assistant

Fall 2018 LUMS CS 300 Advanced Programming (with Dr. Junaid Haroon Siddique)

Teaching Assistant

Spring 2019 LUMS CS 210 Discrete Mathematics (with Dr. Imdadullah Khan)

References

Vikram Adve
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