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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

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

▬▬▬ Experience

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

o 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.

o 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.

o 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

o **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
[Programming Languages]	C/C++, 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

- **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   ASPLOS 2024

Sohaib And Sara Abbasi Computer Science Fellowship

2023-Present   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

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