

JAI ARORA

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EDUCATION

University of Illinois at Urbana-Champaign

Ph.D. in Computer Science

GPA: 4.0/4.0

August 2023 - Present

Thesis Advisor: Prof. Charith Mendis 📧

Indian Institute of Technology Delhi

Dual Degree (B.Tech & M.Tech) in Computer Science and Engineering

GPA: 9.488/10

July 2018 - May 2023

Thesis Advisor: Prof. Sorav Bansal 📧

MAJOR PROJECTS

TensorRight: Automated Verification of Tensor Graph Rewrites *Prof. Charith Mendis, Aug'23 - Present*

- Formalized a core part of the **XLA-HLO** IR using **denotational semantics** in a rank- and size-polymorphic manner
- Implemented a DSL consisting of XLA operators, allowing users to write complex tensor rewrite rules with preconditions
- Developed an automatic verification strategy to verify tensor graph rewrite rules with tensors of arbitrary rank and size

Automated Code Generator for Reconfigurable Dataflow Accelerators *Prof. Charith Mendis, Feb'24 - Present*

- Designing a framework to specify compiler-relevant features of an accelerator & automatically generate its code generator
- Targeting architectures ranging from coarse-grained configuration control to fine-grained dataflow control

Inequivalence Checking across C-programs 📄 *Master's Thesis, Prof. Sorav Bansal, Aug'21 - May'23*

- Explored a sound, **abstract interpretation** approach for establishing **inequivalence** between two given C-programs
- Designed a backwards **Data-Flow Analysis** that operates on product programs and tries to find a distinguishing input
- Found multiple bugs across different C-Library implementations and compared our analysis with state-of-the-art fuzzers

Data Driven Synthesis of Hash Functions *Prof. Subodh Sharma, Nov'20 - Feb'21*

- Implemented a **Program Synthesis** approach which generates appropriate hash functions suited to the input datasets
- Used **Stochastic Search** with various cost metrics to get hash functions that are better than state-of-the-art functions

Dynamic Partial Order Reduction *Prof. Subodh Sharma, Mar'22*

- Implemented a dynamic approach that tracks interactions among concurrent threads, reducing the size of the state space
- Supported variable accesses and Mutex operations and introduced **Sleep Sets** to reduce the search space even further

Web Application for a Student Database *Prof. Maya Ramanath, Mar'21 - Apr'21*

- Developed a web app for a learning management system to keep track of students, courses, online resources and grades
- Used **PostgreSQL** in back-end to manage the Database; used Flask and HTML in front-end to provide a user interface

Toy C Compiler *Prof. Sorav Bansal, Nov'20 - Dec'20*

- Constructed **AST** of the input program using GNU Bison grammar specifications and supported common C constructs
- Implemented semantic checks & local optimizations on the AST and emitted **LLVM IR bitcode** for the input program

INTERNSHIPS

Sound and Scalable Probabilistic Analysis of Floating Point Kernels *(May'21 - Aug'21)*

Prof. Eva Darulova, Max Planck Institute for Software Systems, Germany

Research Internship

- Formulated a theory to soundly propagate the input moments to outputs using Taylor Approximations for Real functions
- Experimented on a set of **53 FPBench** benchmarks to obtain tight bounds on Floating-Point Kernel output moments
- Used Branch-and-Bound strategies to reduce over-approximations; used Parallelism & caching to achieve **3x-4x** speedups

Valuation of Dynamic Data in AEP using GNNs *(Jun'22 - Jul'22)*

Adobe Research, India

Research Internship

- Developed a **task-agnostic, metadata-enhanced**, dynamic **data valuation** method for identifying valuable segments
- Modelled segments as temporal graphs and used **LSTMs** & **GCNs** for edge weight prediction to forecast future weights
- Incorporated several notions of value including network centrality, intrinsic diversity & usefulness in downstream tasks

Nirvana Insurance *(Dec'21 - May'22)*

Software Engineering Intern

- Worked on the **RateML** Infrastructure, an in-house Domain specific language, to make it more robust, safe and testable
- Introduced Runtime-Assertions, Native Booleans, Namespacing Support and Regression Testing Mechanism in RateML
- Supported **VS Code Syntax Highlighting** for RateML and worked on a **Deduplication utility** for RateML models

Design and Implementation of Congestion Control endpoints for PERC Algorithms *(May'20 - Jul'20)*

Prof. Ben Leong, NUS, Singapore

Research Internship

- Studied the Linux's TCP stack to examine its suitability for **Proactive Explicit Rate Control (PERC)** Algorithms
- Implemented a transport stack for **s-PERC** - a stateless, distributed algorithm which converges to **max-min fair rates**
- Modified **Linux Kernel's TCP stack** to spawn & exchange control packets between endpoints and implement **s-PERC**

SCHOLASTIC ACHIEVEMENTS

- **PLMW:** Conferred a scholarship for the *Programming Languages Mentoring Workshop*, colocated with PLDI'24 (2024)
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- **CMMRS:** Attended the *Cornell, Maryland, Max Planck Pre-doctoral Research School 2022* hosted in Germany (2022)
- **IIT Delhi Merit Award:** Conferred **5** times for ranking amongst **Top 7%** academic performers in Dept. (2018-2022)
- **Department upgrade:** Among **9** students to secure a Discipline upgrade to CSE Department after First Year (2019)
- **Academic Excellence:** Among **15** students in the batch to secure Semester GPA of **10/10** in the Ist Semester (2018)
- **KVPY Fellowship Award:** Among 1911 students across India based on a 2-tier process by the Govt. of India (2018)

UNIVERSITY SERVICE

- Advanced Compiler Technologies Seminar (CS 591 ACT [🎯]): *Organizer* *Spring 2024*
- Programming Languages (COL226, Prof. S. Arun-Kumar): *Teaching Assistant* *Spring 2023*
- Cryptography (COL759, Prof. Venkata Koppula): *Teaching Assistant* *Fall 2022*
- Introduction to Computer Science (COL100, Prof. Rahul Narain): *Teaching Assistant* *Spring 2021*

RELEVANT COURSEWORK

- CS 522: Programming Language Semantics, Prof. Grigore Rosu *(Spring 2024)*
- CS 598: Machine Learning for Compilers & Architecture, Prof. Charith Mendis *(Fall 2023)*
- COL831: Semantics of Programming Languages, Prof. Sanjiva Prasad *(Spring 2023)*
- COL832: Proofs and Types, Prof. S. Arun-Kumar *(Fall 2022)*
- COL750: Foundations of Automatic Verification, Prof. Subodh Sharma *(Spring 2022)*
- COV882: Language Security, Prof. Sanjiva Prasad *(Spring 2022)*
- COL874: Advanced Compiler Techniques, Prof. Sorav Bansal *(Fall 2021)*
- COL703: Introduction to Logic, Prof. S. Arun-Kumar *(Fall 2021)*
- COL729: Compiler Optimizations, Prof. Sorav Bansal *(Spring 2021)*
- COL352: Theory of Computation, Prof. Ashish Chiplunkar *(Spring 2021)*
- COL728: Compiler Design, Prof. Sorav Bansal *(Fall 2020)*
- COL226: Programming Languages, Prof. Sanjiva Prasad *(Spring 2020)*

TECHNICAL SKILLS

- **Programming Languages:** C, C++, Haskell, Coq, Python, Rosette, SML, OCaml, Go, Java, Scala, Julia, Prolog
- **Softwares & Tools:** Git, LaTeX, LLVM, XLA, PostgreSQL, Vivado Design Suite, MPI, Pandas, Flask