

Alexander J. Root

PHD STUDENT · STANFORD

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Research Interests

My research interests broadly include domain-specific languages, compilers, and architectures for high-performance numerical computing, with an emphasis on visual computing applications.

Education

- Stanford University** 09/2022 - Present
PHD COMPUTER SCIENCE
Advisor: Prof. Fredrik Kjolstad
- Massachusetts Institute of Technology** 06/2021 - 06/2022
MENG ELECTRICAL ENGINEERING & COMPUTER SCIENCE GPA: 5.0 / 5.0
Advisors: Prof. Jonathan Ragan-Kelley & Dr. Andrew Adams
Thesis: Optimizing Vector Instruction Selection for Digital Signal Processing
- Massachusetts Institute of Technology** 09/2017 - 06/2021
SB COMPUTER SCIENCE & ENGINEERING GPA: 5.0 / 5.0
Advisors: Prof. Frédo Durand & Prof. Jonathan Ragan-Kelley
Bachelor's Project: High Performance Image Processing with Fixed-Point Types

Publications

- Alexander J. Root**, Bobby Yan, Peiming Liu, Christophe Gyurgyik, Aart J.C. Bik, Fredrik Kjolstad. *Compilation of Shape Operators on Sparse Arrays*. (to appear in) OOPSLA 2024.
- Peiming Liu, **Alexander J. Root**, Anlun Xu, Yinying Li, Fredrik Kjolstad, Aart J.C. Bik. *Compiler Support for Sparse Tensor Convolutions*. (to appear in) OOPSLA 2024.
- Bobby Yan, **Alexander J. Root**, Trevor Gale, David Broman, Fredrik Kjolstad. *Scorch: A Library for Sparse Deep Learning*. Under Submission. <https://arxiv.org/abs/2405.16883>
- Alexander J. Root**, Maaz Bin Safeer Ahmad, Andrew Adams, Dillon Sharlet, Shoaib Kamil, and Jonathan Ragan-Kelley. *Fast Instruction Selection for Fast Digital Signal Processing*. ASPLOS 2023. <https://doi.org/10.1145/3623278.3624768>
- Maaz Bin Safeer Ahmad, **Alexander J. Root**, Andrew Adams, Shoaib Kamil, and Alvin Cheung. *Vector Instruction Selection for Digital Signal Processors Using Program Synthesis*. ASPLOS 2022. <https://doi.org/10.1145/3503222.3507714>

Experience

- Stanford Compilers Group** 09/2022 - Present
RESEARCH ASSISTANT
Designing compilers for sparse array programming, high-performance graphics, and database queries.
- Adobe Research** 05/2023 - 08/2023
RESEARCH INTERN (COMPILERS)
Designed a domain-specific language for geometric queries that decouples algorithm from accelerator data structure.
- Adobe Research** 06/2022 - 11/2022
RESEARCH INTERN (COMPILERS)
Developed a language and system for improving fixed-point vector instruction selection within the Halide compiler.

MIT Visual Computing Languages & Systems Group

05/2019 - 08/2022

RESEARCH ASSISTANT

Researched projects related to high-performance digital signal processing, including automatic quantization, bounds inference, and vector instruction selection.

Adobe Research

06/2021 - 12/2021

RESEARCH INTERN (COMPILERS)

Developed techniques for constant bounds approximations for use in Halide's compiler.

Intel

01/2021 - 05/2021

RESEARCH INTERN (COMPILERS)

Designed and implemented a new autoscheduler for Halide.

Microsoft

06/2020 - 09/2020

SOFTWARE ENGINEERING INTERN

Contributed to verification infrastructure for access of control of virtual machines.

Lawrence Livermore National Lab

06/2019 - 09/2019

COMPUTATION INTERN

Developed distributed numerical optimization methods in C++.

Iterative Scopes

02/2018 - 08/2018

ASSOCIATE SOFTWARE ENGINEER

Automated and tested large scale image processing and machine vision systems using AWS.

Redding Electric Utility

06/2017 - 08/2017

ENGINEERING INTERN

Implemented query and reporting systems in C++ for financial data sets.

Awards, Fellowships, & Grants

2022-2025 **Graduate Research Fellowship**, NSF

2022-2023 **School of Engineering Fellowship**, Stanford

2020-2021 **Engineering Honor Society Member**, Tau Beta Pi

2019-2021 **National Honors Society Member**, Eta Kappa Nu

2019-2020 **Keel Foundation Undergraduate Research and Innovation Scholar**, MIT

Invited Talks

June 2024. Decoupling Spatial Queries from Accelerator Trees. *Samsung*, Virtual.

April 2023. Fast Instruction Selection for Fast Digital Signal Processing. *UCSD Graphics Seminar*, La Jolla, CA.

Service

SIGGRAPH Asia External Reviewer: 2023, 2024

Mentoring

Summer 2024 **Devanshu Ladsaria**, CURIS Intern, *Optimizing Sparse Array Operations*

Stanford

Spring 2022 **Mario Leyva**, UROP Intern, *Fast Porter-Duff Image Compositing*

MIT CSAIL

2021-2022 **Katherine Mohr**, UROP Intern, *Compiling Fast Term-Rewriting Systems*

MIT CSAIL

Summer 2021 **Evan Lee**, Halide Google Summer of Code Intern, *Rewrite Rules Evaluation*

GSoC

Teaching

Spring 2024	CS 343S: Domain-Specific Language Design Studio , Teaching Fellow	<i>CS, Stanford</i>
Winter 2024	CS 343D: Domain-Specific Programming Models and Compilers , Course Assistant	<i>CS, Stanford</i>
Winter 2023	CS 343D: Domain-Specific Programming Models and Compilers , Course Assistant	<i>CS, Stanford</i>
Fall 2021	6.818: Dynamic Computer Language Engineering , Teaching Assistant	<i>EECS, MIT</i>
Spring 2020	6.006: Introduction to Algorithms , Teaching Assistant	<i>EECS, MIT</i>
Spring 2019	6.006: Introduction to Algorithms , Teaching Assistant	<i>EECS, MIT</i>
January 2019	MIT Global Teaching Labs (Middle East) , Computer Science Instructor	<i>MIT MEET</i>