Alexander J Root

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Education

Stanford University *09/2022 - Present*

Ph.D. in Computer Science GPA: 4.0/4.0

- Advisor: Fredrik Kjolstad

Massachusetts Institute of Technology *06/2021 - 06/2022*

M.Eng. in Electrical Engineering & Computer Science GPA: 5.0/5.0

- Advisors: Jonathan Ragan-Kelley and Andrew Adams
- Thesis: Optimizing Vector Instruction Selection for Digital Signal Processing

Massachusetts Institute of Technology *09/2017 - 06/2021*

S.B. in Computer Science & Engineering GPA: 5.0/5.0

- Advisors: Frédo Durand and Jonathan Ragan-Kelley
- Bachelor's Project: High Performance Image Processing with Fixed-Point Types

Research Experience

Stanford Compilers Group *Sept 2022 - Present*

PhD Student Researcher under Fredrik Kjolstad Stanford, USA

- Researching domain-specific compilation techniques for high-performance irregular computations. I have developed compiler techniques for both sparse array programming [1, 2, 3] and spatial computing (e.g. ray-tracing and collision detection) [6, 7].

MIT Visual Computing Languages & Systems Group *May 2019 - Aug 2022*

Undergraduate and Master's Researcher under Jonathan Ragan-Kelley, Andrew Adams, and Frédo Durand. Cambridge, USA

- Researched projects related to high-performance digital signal processing, including automatic quantization, bounds inference, and vector instruction selection [4, 5].

Publications

Refereed Conference and Journal Papers

[1] Bobby Yan, **Alexander J Root**, Trevor Gale, David Broman, Fredrik Kjolstad, "Fast Autoscheduling for Sparse ML Frameworks". In: *Proceedings of the 24th ACM/IEEE International Symposium on Code Generation and Optimization*. CGO '26. Sydney, Australia: Association for Computing Machinery, 2026. URL:

[2] **Alexander J Root**, Bobby Yan, Peiming Liu, Christophe Gyurgyik, Aart J.C. Bik, Fredrik Kjolstad, "Compilation of Shape Operators on Sparse Arrays". In: *Proc. ACM Program. Lang.* 8.OOPSLA2 (Oct. 2024). DOI: 10.1145/3689752. URL:

[3] Peiming Liu, **Alexander J Root**, Anlun Xu, Yinying Li, Fredrik Kjolstad, Aart J.C. Bik, "Compiler Support for Sparse Tensor Convolutions". In: *Proc. ACM Program. Lang.* 8.OOPSLA2 (Oct. 2024). DOI: 10.1145/3689721. URL:

[4] **Alexander J Root**, Maaz Bin Safeer Ahmad, Dillon Sharlet, Andrew Adams, Shoaib Kamil, Jonathan Ragan-Kelley, "Fast Instruction Selection for Fast Digital Signal Processing". In: *Proceedings of the 28th ACM International Conference on Architectural Support for Programming Languages and Operating Systems, Volume 4*. ASPLOS '23. Vancouver, BC, Canada: Association for Computing Machinery, 2024, pp. 125–137. ISBN: 9798400703942. DOI: 10.1145/3623278.3624768. URL:

[5] Maaz Bin Safeer Ahmad, **Alexander J Root**, Andrew Adams, Shoaib Kamil, Alvin Cheung, "Vector instruction selection for digital signal processors using program synthesis". In: *Proceedings of the 27th ACM International Conference on Architectural Support for Programming Languages and Operating Systems*. ASPLOS '22. Lausanne, Switzerland: Association for Computing Machinery, 2022, pp. 1004–1016. ISBN: 9781450392051. DOI: 10.1145/3503222.3507714. URL:

Under Review

[6] **Alexander J Root**, Christophe Gyurgyik, Purvi Goel, Kayvon Fatahalian, Jonathan Ragan-Kelley, Andrew Adams, Fredrik Kjolstad, *Compiling Set Queries into Work-Efficient Tree Traversals*. Under Review. 2025. URL:

[7] Christophe Gyurgyik, **Alexander J Root**, Fredrik Kjolstad, *Data Layout Polymorphism for Bounding Volume Hierarchies*. Under Review. 2025. URL:

Work Experience

NVIDIA Research *May 2025 - Present*
Research Intern (Real-Time Graphics) San Francisco, USA
• Designing a scheduling language for divergent and data-dependent recursive workloads (e.g. path tracing or WoS).

Adobe Research *May 2023 - Aug 2023*
Research Intern (Compilers) San Francisco, USA
• Designed a domain-specific language for geometric queries that decouples algorithm from accelerator structures [6].

Adobe Research *June 2022 - Nov 2022*
Research Intern (Compilers) Virtual, USA
• Developed a language and system to improve fixed-point vector instruction selection for the Halide compiler [4].

Adobe Research *June 2021 - Dec 2021*
Research Intern (Compilers) Virtual, USA
• Developed techniques for constant bounds approximations and vector instruction selection [5].

Intel *Jan 2021 - May 2021*
Research Intern (Compilers) Virtual, USA
• Designed a new autoscheduler for Halide. Achieved $2\times$ faster compilation with $1.06\times$ faster runtime.

Microsoft *June 2020 - Sept 2020*
Software Engineering Intern Virtual, USA
• Contributed to verification infrastructure for access of control of virtual machines.

Lawrence Livermore National Lab *June 2019 - Sept 2019*
Computation Intern Livermore, USA
• Developed distributed numerical optimization methods in C++.

Iterative Scopes (now Iterative Health) *Feb 2018 - Aug 2018*
Associate Software Engineer Cambridge, USA
• Automated and tested large scale image processing and machine vision systems.

Redding Electric Utility *June 2017 - Aug 2017*
Engineering Intern Redding, USA
• Implemented query and reporting systems in C++ for financial data sets.

Teaching Experience

CS 343S: Domain-Specific Language Design Studio *Spring 2024 and 2025*
Teaching Fellow/Lecturer Stanford University
• Developed and taught new class on design and implementation of domain-specific languages.

CS 343D: Domain-Specific Programming Models and Compilers *Winter 2023 and 2024*
Course Assistant under Fredrik Kjolstad Stanford University
• Developed coursework, gave lectures, ran office hours, graded assignments, and managed course logistics for a research seminar on domain-specific languages.

6.818: Dynamic Computer Language Engineering *Fall 2021*
Teaching Assistant under Michael Carbin MIT
• Gave lectures, ran office hours, graded assignments, and managed course logistics for a project-oriented class on designing JIT compilers.

6.006: Introduction to Algorithms *Spring 2019 and 2020*
Teaching Assitant under Jason Ku MIT
• Taught 20 student recitations twice a week, ran office hours, and graded assignments for introductory algorithms.

Mentoring

Christophe Gyurgyik *Summer 2024 - Present*
Stanford Ph.D. (expected) 2028 Stanford

- Chris and I developed SCION [7] as an extension of our work on BONSAI [6]; we are still exploring layout polymorphism to enable productive high-performance programming in other domains besides graphics.

Atharva Chougule *Fall 2025 - Present*
Stanford M.S. (expected) 2027 Stanford

- Investigating methods for compiling sparse tensor algebra to load-balanced GPU kernels.

Devanshu Ladsaria *Summer 2024 - Present*
Stanford B.S. 2025 and M.S. (expected) 2026 Stanford

- Developing a DSL for tree-construction algorithms, unifying existing techniques into concise, portable forms.

Ishita Gupta *Fall 2024 - Spring 2025*
Stanford B.S. 2025 and M.S. (expected) 2026 Stanford

- Explored designing a domain-specific memory allocator for high-performance CPU renderers.

Katherine Mohr *2021-2022*
MIT S.B. 2023 and M.Eng. 2024, now Stanford CS Ph.D. student MIT

- Developed a compiler for pattern matching rewrite rules in the Halide compiler, to improve the performance of term-rewriting-systems (extensively used throughout code generation).

Mario Leyva *Spring 2022*
MIT S.B. 2022 and M.Eng. 2023, now Software Engineer at Google MIT

- Implemented fixed-point Porter-Duff image compositing algorithms in Halide, in an effort to find more benchmarks for Pitchfork [4].

Evan Lee *Summer 2021*
University of Waterloo, B.S. 2024, now Compiler Engineer at Meta Google Summer of Code

- The first Google Summer of Code intern for the Halide language. He ran an evaluation of the performance impact of adding synthesized rewrite rules to the Halide expression simplifier, showing that only 10% of the rules were necessary to achieve the performance gains promised in the paper.

Honors and Awards

Innovation Fellowship (QIF) *2025 - 2026*
Qualcomm

Graduate Research Fellowship (GRFP) *2022 - 2025*
National Science Foundation (NSF)

School of Engineering Fellowship *2022 - 2023*
Stanford

National Engineering Honor Society Member *2020*
Tau Beta Pi (TBP)

National Electrical Engineering Honor Society Member *2019*
IEEE–Eta Kappa Nu (HKN)

Keel Foundation Undergraduate Research and Innovation Scholar *2019 - 2020*
Massachusetts Institute of Technology

Talks

Decoupling Spatial Queries from Accelerator Trees *Virtual*
Qualcomm Codegen Seminar Oct 2025

Decoupling Spatial Queries from Accelerator Trees *Half Moon Bay, CA*
PORTAL Retreat Aug 2025

Decoupling Spatial Queries from Accelerator Trees *Virtual*
Samsung Invited Talk June 2024

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

Service

High Performance Graphics (HPG) Web Chair *2026*

Transactions on Graphics (ToG) External Reviewer *2025*

SIGGRAPH Asia External Reviewer *2023 - 2025*